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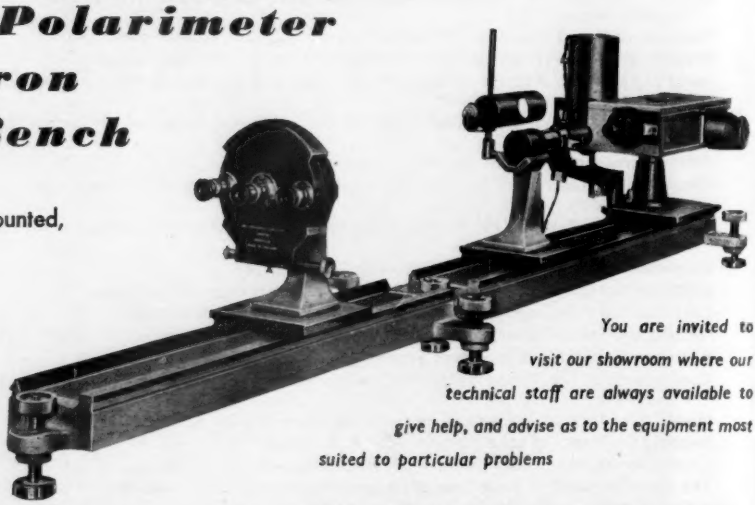

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EDUCATION AND THE RHODES TRUST

THE record of the first fifty years of the Rhodes Trust and the Rhodes Scholarships which has been compiled in connexion with the jubilee of the Trust* is intended primarily for domestic consumption by former Rhodes Scholars, to whom it is being presented. Informal and episodic and admirably produced, its composite authorship does not disturb the unity of the book but rather testifies to the unifying power of the ideal which men of such varied outlook, ability and temperament as Lord Elton, Sir Francis Wylie, Sir Carleton Allen and Frank Aydelotte (American Secretary during 1918–52) have sought to promote. It does not, indeed, claim to be a history of the Rhodes scholarships, still less of the Rhodes Trust. Lord Elton, writing of the Rhodes Trust, endeavours to provide the background against which the personal reminiscences of the Rhodes Scholars in Oxford by Sir Francis Wylie and Sir Carleton Allen, which constitute the core of the book, and Frank Aydelotte's account of the American Scholarships and their administration, may be read. Lord Elton's contribution, in particular, contains shrewd comments and observations on educational issues of the day. A foreword written by Mr. L. H. S. Amery, who died while the volume was in the press, rightly suggests that the story told in its pages has a close bearing on wider educational issues, even if it gives no convincing answer to the question: What did Cecil Rhodes hope to produce by his Foundation? There are, it is true, answers, in some measure, to two other questions noted by Mr. Amery: What has Rhodes's benefaction enabled Oxford to give to those for whom it was intended and to the world outside? And what has Oxford, as a University, itself gained from that benefaction? That those answers are incomplete adds to, rather than detracts from, the value of the book. For it is not only a readable and lively if informal historical record, but also a timely contribution to live issues in higher education to-day. It is timely for the sufficient reason that the record makes it quite clear that generations are required to judge the full effect of experiments in education.

Such a reminder is timely when Britain is faced with the imperative need to expand its system of technological and technical education. It is not always fully appreciated that there is no time to experiment with a technological university—if by that is meant that full expansion must wait until the lessons can be drawn years hence from the results of that experiment. The decision as to what form the expansion of technological education in Britain should take must be based on the abundance of existing experience, and the argument for a technological university rests, in part, on the possibility that a new departure in the British context might yield fresh experience and unexpected results. There is always room for variety in education, but the report on the Rhodes Trust, while testifying to that truth, is equally a warning against committing limited resources excessively to a new departure before we are clear where it will lead.

The warning is needed in other fields besides technological education, and there is another warning to be found in these pages. Even in these fifty years the setting of the Rhodes Trust and of the Rhodes Scholars has changed. Oxford is not to-day the Oxford that Cecil Rhodes knew. As Lord Elton points out, "in the Founder's day, the clamant demand for knowledge as such, the paramount emphasis upon research as the primary duty of a university, was virtually unknown. Mr. Rhodes pictured his Scholars drinking deep of the humanities and rubbing shoulders with their coevals in the College common-rooms and quadrangles rather than as enlarging the sum of human knowledge over a laboratory retort". While to-day the fervour for research is still increasing all over the world, the much wider social strata on which, with economic changes, Oxford now draws has made the University yet more unlike the University of fifty years ago.

These changes have set problems in the administration of the Trust; nor are they altogether avoidable. In deciding education policy which may shape educational institutions for decades ahead, care therefore should be taken to ensure flexibility. It is not merely that the needs of the society which the institutions exist to serve may change, that some functions may become obsolete, that new needs may arise and require service: the nature of society itself may change, and institutions admirably adapted to one form may consort ill with the new one. We need to keep room for manœuvre and for putting more ideas and methods to the proof, and to avoid committing irretrievably the nation's resources into one form which may either fail to fulfil its initial promise or, in unforeseen and changing circumstances, prove less suitable and efficient than was expected.

This is, of course, precisely the argument for the independent institution as the growing point of society in education, no less than in research. This record, moreover, shows the value of the independent and unofficial institution in another respect. The effect of the increasing place which research has come to hold in the life of the university has already been noted, and it has been hinted that this has raised problems for the Rhodes Trustees. Even in 1929, however, the relative advantages of honour schools and postgraduate research were being debated at a conference of members of the selection committees and university officials, most of whom held that Rhodes Scholars should continue to take the undergraduate course at Oxford, as the best and most characteristic teaching which Oxford offered. Most of them also agreed that the importance of higher

* The First Fifty Years of the Rhodes Trust and the Rhodes Scholarships, 1903–1953. Edited by Lord Elton. Pp. xiv+268+19 plates. (Oxford: Basil Blackwell, 1955.) 27s. 6d. net.

degrees and research work as a method of education was largely over-estimated. Nevertheless, in his subsequent memorandum to selection committees, Lord Lothian made it clear that a growing proportion of the ablest men could not be expected to compete for Rhodes Scholarships unless adequate facilities for postgraduate study were developed at Oxford.

Seven years later, in 1936, when recommending the Trustees to contribute £100,000 to the projected University of Oxford Appeal, Lord Lothian pointed out that no university could keep in the front rank unless a considerable proportion of its leading figures were actively engaged in extending the limits of human knowledge, rather than in imparting to successive generations of students the body of learning which they themselves had inherited from their predecessors. In making this gift of £100,000, the Trustees expressed the wish that it should be used to support research in social studies with special reference to "the problems of modern government in the British Commonwealth and the American Republic". Oxford had indeed been chosen by Rhodes because he regarded the study of Greek culture and Roman law as invaluable for young men who were likely to be called upon to practise the art of government.

Education for management and administration and for the art of government was clearly in the mind of the founder of the Trust—or, as perhaps it might be better put to-day, education for leadership. The selection of Rhodes Scholars has obviously been guided by the desire to choose those best fitted by character and intelligence to develop as leaders of their generation in the various walks of life and progress most towards that end by the opportunities which Oxford offers. Nevertheless, there are two important points which any reading of this survey in such a context suggests need fuller consideration.

So far back as 1927, Lord Lothian had expressed doubt whether an increasing tendency then becoming apparent among Rhodes Scholars from the Commonwealth to study the sciences rather than the arts was an advantage from the point of view of Mr. Rhodes's larger ideals. The founder, he argued, had selected the University of Oxford largely because he believed that the type of education given there, with its outlook on the civilization of Greece and Rome, its interest in philosophy, history, law and political science, would develop in his Scholars those attitudes which would specially assist them in the discharge of public duties in after-life. It is not under-rating the value of a scientific education at Oxford or elsewhere to suggest that this point of view should be remembered in the current debates on general education and education for management and leadership.

Sir Carleton Allen makes a specific point in this connexion. He knows of no place where the use of the English language is more sedulously disciplined than at Oxford. "Looseness, verbosity or vulgarity of expression are of all things anathema, and it is, or ought to be, an axiom of tutorial instruction that bad style is bad thinking." If Rhodes Scholars take nothing else from Oxford, they will be in her debt, he suggests, if they have learned to weigh their words before committing them to speech or paper.

Oxford's special strength may well lie, as Sir Carleton suggests, more in its tutorial system than in its supervision of research, and even in the natural sciences, where the research technique of Oxford is most highly developed, there is danger that a Rhodes Scholar may become so tied to his laboratory that he is alienated from the more miscellaneous but educative activities of student life. We may accept, too, that the man who is living in college and working under a good tutor is more likely than the specialist to get the characteristic flavour of Oxford and enter into the main current of its life, and that not every Rhodes Scholar will profit more by postgraduate work than by a 'final honour school'. If, however, a scientific discipline fails to impart precisely that care in the use of the English language which Sir Carleton lays down as characteristic of Oxford, there is something wrong with the teaching of those disciplines. It is not that science is not worth study by the Rhodes Scholar, but that the teaching of science should be on a par with the teaching of those other disciplines in which Oxford has been pre-eminent.

This is an important point, for we cannot expect the Rhodes Scholar to take the place in the world of to-day and to-morrow that the founder of the Trust envisaged unless he is equipped to understand the forces which are moulding it and the way in which they work. An understanding of science and its method is as essential a part of the equipment of the administrator or statesman to-day as the ability to weigh his words and communicate his ideas clearly and concisely. It is also true that the Rhodes Scholars are unlikely to exert their full influence on the world of to-day unless a reasonable proportion of them enter the world of science; and this does not appear to be happening, at least on the evidence provided by the records and statistics collected by Sir Carleton Allen.

Among the Commonwealth Rhodes Scholars, the proportion studying sciences has increased from 54·2 per cent before the First World War to 68·1 per cent between 1918 and 1925, but fell to 35 per cent in 1954; among American Rhodes Scholars the corresponding figures are only 12·2, 14·7 and 16 per cent. While the roll includes such names as those of Dr. Wilder G. Penfield, Sir Howard Florey and Sir David Rivett, the analysis of vocations of former Rhodes Scholars reveals only six who pursued agriculture and animal husbandry, 46 chemists (chiefly industrial), 79 engineers, 19 foresters, 15 geologists and geophysicists, 171 medicals, 66 other scientists, mainly physicists, besides 3 anthropologists and one archæologist who could possibly be included under science, a total of 406 out of the 2,571 Scholars elected up to 1949 whose careers are recorded by Sir Carleton Allen. It does not, however, take account of the 138 scientists included in the 618 Scholars who adopted an academic vocation.

Sir Carleton Allen also notes that postgraduate work is attracting an increasing proportion of Rhodes Scholars, the percentage of those reading for research

degrees ranging from 30 to 41 between 1947 and 1953, and of these nearly one-half are engaged in one or other of the natural sciences. Nevertheless, it is more than doubtful whether, however carefully the Rhodes Scholars continue to be selected, they will make in the future the powerful contribution to the national life of the countries from which they come or in which they elect to spend their professional life, unless something more than a fifth of them on average have studied the sciences. It would be fatal to that influence in an age in which nuclear physics is placing such immense possibilities for good or evil in the hands of men if the impression prevailed that, as a class, the Rhodes Scholar usually lacked first-hand acquaintance with the forces that are shaping the world.

Admittedly, science is not the only force involved, but it cannot be ignored and it can only be guided if understood. We need more than ever that influence upon the outlook on intellectual and moral problems which Rhodes Scholars have exercised upon all the professions they have taken up. That influence, derived essentially from Oxford, is described by Mr. L. H. S. Amery as one of the most important services rendered by the Rhodes Scholar; and he concedes, too, that the practical needs of the Rhodes Scholars have steadily reinforced the growing recognition of the importance of research, of the fact that a great university cannot live merely by transmitting an existing body of knowledge and ideas but must make its contribution to the body of knowledge. The Rhodes Scholars must therefore keep in the full stream of modern life and represent and interpret not merely the best traditions of the past and aspirations of the present but equally the forces that are shaping the future.

There is one point noted by Lord Elton in discussing the influence of the scholars and the scholarships which has its bearing on the problems of higher technological education and the general education of both the scientist and the arts graduate in Great Britain. Lord Elton believes that the care taken in selecting Rhodes Scholars for their possession of character as well as of intelligence makes the Rhodes scholarships an even more important influence for good in the life of a university. Until recent years, the tendency in our general scholarship system to concentrate exclusively on the possession of intellectual qualifications has been largely offset by the fact that a high proportion of those obtaining scholarships came from Public Schools, in which emphasis has always been laid upon the training of character. These schools no longer supply the same proportion either of 'open scholars' or of the general body of undergraduates, and at the same time the life of a university is also impoverished by a decrease in the numbers of those, adequately industrious and intelligent, but whose independent means enable them to take a more active part in the social and athletic life of college and university.

This is a trend of which due account should be taken in expanding the provision for higher technological education in Britain, and in our plans to meet the impending 'bulge' in university students in the 'sixties. We cannot rely entirely, even at Oxford, on the beneficial influence of the Rhodes Scholars. But at the least, this inspiring account of the translation into practice of a great ideal is a reminder of the importance of vision and flexibility where educational institutions are concerned, of the need to avoid hasty judgments and preconceived ideals, and of allowing for more ways than one for achieving our purpose before we take decisions which may affect the welfare and service of the State not merely to-day but for a generation or more to come. The Rhodes Trust and the Rhodes scholarships are a supreme demonstration of the truth of Sir Ernest Barker's words in "Age and Youth": "I had always felt that much of what was great and fine in the history of my country —much in its religious life, much in its system of education, much in its development overseas into a Commonwealth of free nations, much in its system of parties and in its general system of self-government—was ultimately based on my countrymen's habit of doing things together for themselves in voluntary co-operation".

FOOD PROBLEMS IN THE UNITED STATES

Handbook of Food and Agriculture

Edited by Fred C. Blanck. Pp. vii+1039. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.) 100*s*. net.

THIS is a remarkable book. It is a collection of twenty-six chapters, each by separate authors, of whom there are twenty-nine: it runs to more than a thousand pages of about five hundred words to a page, and it deals with almost every aspect of food production, processing, packing and delivery, especially with the last three items. The section on production is the lightest, consisting of four chapters only, dealing respectively with soils, soil fertility, soil microbiology and fertilizers, covering altogether less than a hundred and fifty pages. Within the limits of space thus imposed, the accounts are good and include most of the subjects recently investigated in America. There are few references to work done outside the United States: in the account of the fixation of nitrogen by leguminous plants, no mention is made of H. G. Thornton's classical investigations; and in describing composts, the need for adding a source of nitrogen such as calcium cyanamide to feed the bacteria and thereby hasten decomposition, which was demonstrated by H. B. Hutchinson and E. H. Richards at Rothamsted in 1921 and formed the basis of the 'Adco' patent, is attributed to an American investigator in 1948. Nor in the fertilizer section is any reference made to the Rothamsted experiments or to the need for proper statistical control of the design of the field experiments and the discussion of the results.

The book must be read, therefore, as principally a statement of American results, and from this point of view it is a mine of interesting and valuable information. Thanks to the friendly co-operation between the soil workers in Britain and in the United States, the material in the chapters on soil is pretty well known to experts in the former country. Some of the information on fertilizers, however, will be

new to many readers. Soil conservation activities in the United States have raised the consumption of liming materials from 3·3 million tons a year in 1935 to 13·1 million tons in 1940 and 26·5 million tons in 1950. Prior to 1900, organic manures supplied more than 90 per cent of the nitrogen added to the soil; since 1950 they have supplied less than 4 per cent, the rest being from chemical fertilizers. These supply more than a million tons of nitrogen a year, much of it in the form of ammonium sulphate, but a large and increasing use is made of free ammonia, for which special appliances have been designed. Slow-acting nitrogenous fertilizers based on urea are coming into use, and promise to solve some of the grower's difficulties; it is interesting to note that for this purpose urea has to be imported. As in the United Kingdom, American farmers show a decided preference for mixed fertilizers over single ones; the general formula has changed in the same direction: prior to 1915 the ratio $N : P_2O_5 : K_2O$ was 1 : 4 : 1; it is now approximately 1 : 2½ : 2. There is a tendency also to use more concentrated fertilizer, but granulation is not as usual as in Britain. A very informative chapter on pest control agents includes some pages of constitutional formulæ of the more common organic substances used for this purpose and made on an increasingly large scale—a triumph of modern chemical technology. The need for these control agents is growing: the damage done annually in the United States by insects is roughly estimated at 4 thousand million dollars, by plant diseases at 3 thousand million dollars, and by weeds at more than is done by insects and all plant and animal diseases put together. The authors state that the apple grower "has to compete with 200 infectious diseases and 100 insect pests in order to produce a marketable crop"; it is not surprising the United States Department of Agriculture has a list of thirty thousand pesticidal formulations.

Most of the book is occupied by the processing, storage, packing and transport of foods; these chapters are a rich mine of interesting and sometimes intriguing information. Wheat is made into a number of different foods, in all of which it can be recognized. But maize can be used in making a surprising number of products of the most diverse character: foods for man and beast, antibiotics, cosmetics, chewing gum, explosives, rayon, tobacco, paper, soap, ice cream and various other things. The book ends with some useful chapters dealing respectively with control of quality in food, the disposal of food-plant wastes, and the use of chemicals in food. Altogether, it is an interesting volume.

But it is dear. Its price in Britain is £5—a reflexion, no doubt, of the high cost of production in the United States, but all the same hard on a British buyer.

E. John Russell

THE EXTRA PHARMACOPŒIA

The Extra Pharmacopœia (Martindale)
Vol. 2. Twenty-third Edition in two volumes. Pp. xxxi+1501. (London: Pharmaceutical Press, 1955.) 57*s.* 6*d.*

THIS book, which is the latest reincarnation of the second volume of the famous work by Martindale and Westcott, contains a large amount of compact information. The two volumes of the twenty-third edition together contain more than 2,850 pages. The first edition was published in 1883 and contained only 313 pages, and the book grew slowly at first and then rapidly between 1900 and 1910. Since then it has grown at a fairly steady rate, but the interval between editions has increased from two years up to eleven or twelve, so that the amount of matter added with each edition has increased. It is a pity that the interval has grown so long, but the labour involved must be enormous.

In this Vol. 2 about 450 pages are devoted to analytical addenda to Vol. 1—the methods by which the pharmacists ensure that the drugs we use contain the proper ingredients and nothing more. Sections are devoted to *p*H, oxidation potentials, polarography, indicators, ion-exchange resins, chromatography, spectrophotometry, fluorimetry, the microbiological assay of vitamins, food analysis, water analysis, sterilization, disinfectants, radiotherapy, electrotherapy, nutrition, hæmatology, clinical biochemistry and various other topics which come within the wide range of subjects which the pharmacist understands.

The section on the nomenclature of organic compounds has developed gradually through several editions, and will now be very valuable to those who have to try to understand organic structures without being organic chemists. It is a pity, however, that there seems to be no clue to the meanings of the prefixes such as *cis* and *meso* mentioned on p. 768, and surely *nor* means "N ohne radikal" and not "the next lower homologue".

There is a stimulating section on what the Americans call SAR (structure action relationships), but sulphanilamide was not the first useful drug the action of which was traced to its close resemblance to a natural metabolite (p. 780). The theory that some drugs act in this way had been widely discussed in connexion with eserine, atropine, ephedrine and other drugs for many years before it was applied to sulphanilamide.

Enough has perhaps been said in this review to show that the book not only gives much information, but also provokes thought. It is a worthy successor to a long line of famous forerunners.

J. H. Gaddum

ANTHROPOMETRY AND HUMAN ENGINEERING

Anthropometry and Human Engineering
A Symposium on Anthropometry, Human Engineering and Related Subjects conducted by the AGARD Aeromedical Panel on 3 and 4 May 1954 in Scheveningen, The Netherlands. (AGARDograph No. 5.) Pp. iv+123+3 plates. (London: Butterworths Scientific Publications, 1955; published for A.G.A.R.D.) 21*s.*; 3 dollars.

THIS publication originated from a symposium conducted by the Aeromedical Panel of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, and shows a well-defined grouping of related papers. The various approaches by the different authors add considerable interest to what could be a heavy subject. Its scope is wide, and it should be of interest to the aeronautical engineer and applied psychologist. Indeed, the latter may be impressed by the scope and importance of the work in his field introduced in this

volume. Basic concepts of instrument display and design are explained in a lucid manner. It is apparent that controversial issues are developing rapidly, and there is a great need for more fundamental research along these lines. In this respect, the topics introduced by the various specialists in aviation medicine and psychology point out shrewdly the future trends. Anyone concerned with instrument design outside the aviation industry might well take heed of these aspects of human engineering which have a universal application.

The papers devoted to anthropometry indicate the impetus given to statistical work of this nature by aviation in general. In the man/aircraft combination, the work space is critical, and approximately one-third of the book is devoted to this subject, which includes a large-scale survey of body measurements carried out in the French Air Force. Research and applications carried out for the Royal Air Force are summarized in an excellent manner and point out to the engineer his responsibility in this field.

The third part of the book, dealing with related subjects, is essentially the general medical application of the previous concepts to aviation. For example, a paper on somatotyping by P. M. van Wulfften Palthe (Netherlands) usefully supplements the French statistical survey. It is suggested that anthropometric studies may be linked with psychological profiles drawn up by air-crew selection boards according to the principles developed by Kretschmer and Sheldon. Altogether, the book should arouse wide interest and appeal to many not directly concerned with aviation.

F. LATHAM

SERVO-MECHANISMS AND CONTROL SYSTEMS

Engineering Cybernetics

By H. S. Tsien. Pp. xii+289. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 46*s*. 6*d*.

WHEN a new book arrives on my desk nowadays, I am always hoping that it may not be yet another book on servo-mechanisms and control. Usually it is the mixture as before: a few hackneyed phrases to be written about the ever-growing need for more automatic control in industrial processes; the need for a sound mathematical background; the wide interpretations of the concept of feedback; the accelerated growth of a new science, etc. For the market is flooded with books on the subject. When I saw the title of the volume under notice, "Engineering Cybernetics", my fears were roused, and I must admit to approaching the work with a sense of irritation and in an antagonistic mood. The author has done himself a great disservice in choosing such a misleading means of introducing his book; for a glance at the contents and the preface shows it to be confined strictly to the field of mechanism, making no reference to biological matters or sociological affairs.

But if the title was a frightening thing, the contents were a soothing balm—for this book turned out not to be the same old medicine. Regarded strictly as a text upon the theory of servo-mechanisms and control systems, and nothing else, it is honest and excellent. A great deal of material will be found which is not readily available, to my knowledge, in any other collected form. It can be recommended to the attention of fairly advanced students of servo-mechanism theory, feedback and control processes. In his preface the author excuses the title on the grounds that it denotes ". . . an engineering *science*, whereas servo-mechanism engineering is an engineering *practice* [italics his]. . . . No gadget is mentioned". But I protest: gadgets are mentioned. The book is full of them—diagrams and sketches of springs and dashpots, amplifiers and air-foils, relays and rockets; and a good thing too, for such intellectual prudery is quite out of place. Further, one excellent point of this volume is the great number of fully worked examples—really practical ones.

The author has succeeded well in presenting the essential mathematical techniques, methods and concepts, with explanations and illustrations drawn from a great variety of engineering mechanisms. The introductory sections perhaps serve little purpose, being bare facts about Laplace transforms, lists of operations, and rapid surveys of the mathematical elements; this is a fault which seems very common in many American text-books of this type. Either the reader must know his elements already or he must study them seriously, and at laborious length; he will gather little understanding from the sort of distillations so frequently seen. But this book very soon gets down to work. After a few chapters presenting what is by now the classical treatment of feedback mechanisms, more modern material is introduced. Systems with several controlled quantities are studied, with their interactions; and the need for new stability criteria is considered, with representation of such system behaviour by transfer-function matrices. A small criticism is that several electrical engineering terms, such as 'carrier', 'filter', are used without explanation. Would not a few words help mechanical engineers?

Systems having statistical inputs are taken next, after a good introduction to random process theory: averaging, correlation, power spectra, moments. Then relay servos are treated, their stability being examined by a modification of the well-known Nyquist criterion. This continuity of concept, with extension as proves necessary, is a most commendable policy adopted here. The student can hang on to reality a long while in terms of his existing mental images; and it becomes very clear when, and why, such images fail utterly and must be abandoned.

The work continues with the general properties of non-linear systems, and then with systems having variable coefficients, at which point the classical transform approach must be abandoned. Later chapters deal with the design of specific systems by perturbation theory; here, almost the entire work centres around one class of practical problem—the design of guided missiles to follow prescribed trajectories, or to seek a prescribed target—and the author reveals his own specialization. This problem is carried to great lengths, and includes allowance for the effects of atmospheric variations, for missile manufacture tolerances, etc. Both analysis and synthesis are studied.

There is a good deal of valuable descriptive material, besides the formal mathematics, in this book, giving some notion of purpose, of design difficulties, reasons for choice of methods and other matters so commonly omitted from such books—perhaps not being understood by the theoreticians writing them. But I would beg the author to change the title before a second edition.

COLIN CHERRY

Gas Dynamics of Cosmic Clouds

A Symposium held at Cambridge, England, July 6–11, 1953. Edited by H. C. van de Hulst and J. M. Burgers. (International Union of Theoretical and Applied Mechanics and International Astronomical Union. I.A.U. Symposium Series—No. 2.) Pp. xii+247+12 plates. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1955.) 19 Dutch florins; 38*s*.

THE forty-four chapters in this book are mainly amended texts of papers and edited versions of discussions which took place at a symposium in Cambridge two years ago, and they were up to date in the summer of 1954. The meeting was the second of its kind, the first having been held in Paris in 1949. The report of the 1949 meeting, published under the title "Problems of Cosmical Aerodynamics" (Dayton, Ohio: Central Air Documents Office, 1951), gave the impression that the dynamics of cosmic clouds was a well-understood subject and that, for example, one needed only conventional turbulence theory, correctly applied, to explain the spiral structure of our galaxy and the motion of interstellar material.

The present report is quite different. There are many problems left after all. To take a few: Has our galaxy got spiral or circular arms and can present methods of observation ever tell us unambiguously? Do interstellar clouds sometimes condense to form new bright stars? If so, what happens to their angular momentum? Does uneven heating by these stars cause the irregular motion of the gas clouds? Do the clouds really move at Mach five, or even ten? What kind of theory applies to this type of turbulence?

The aerodynamicists at the symposium tried to help with reports of theoretical and practical studies, but contact was not really made: the phenomena to be explained are still a little too complex. However, the book makes stimulating reading and contains some very fine pictures. Even the reports of the discussions are worth looking at, for that is where many of the best remarks were made.

F. D. Kahn

Papirová Chromatografie

Edited by Dr. I. M. Hais and Dr. K. Macek. Pp. 720+10 plates. (Praha: Nakladatelstvi Československe Akademie Věd, 1954.) Cena brož, 136 Kčs.; vaz, 142 Kčs.

AS this book is written in the Czech language and is evidently intended mainly for workers in Czechoslovakia, any detailed comments would not be of interest to most readers of these columns; but it may be pointed out that the book provides Czech workers with a guide to all aspects of paper chromatography that is as useful as any which has been published outside that country. Among many valuable features are the detailed discussions of the applications of paper chromatography in structural studies of proteins and polysaccharides and of the applications of polarographic methods in quantitative work, topics which have not always received the attention they deserve in the books on chromatography.

The bibliography contains well over four thousand references and covers the literature up to 1953. As the title of each reference is given in full in its original language, this bibliography is of universal value and is probably the best source for Czech, Hungarian and Russian references. Another feature of general interest is the systematic list of a large number of reagents for detecting substances on chromatograms and of buffer systems used in paper electrophoresis. These directions can be fairly well followed even without a knowledge of Czech. It is to be hoped that copies of this treatise will be made available at least to the larger science libraries in countries outside Czechoslovakia.

R. Consden

Elementary Introduction to Molecular Spectra

By Børge Bak. Pp. x+126. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1954.) 9 Dutch florins; 18*s*.

A BOOK on molecular spectra as concise as this one deserves serious consideration. Excellent monographs which treat in detail of various aspects of the subject exist, and their number is added to year by year, but there remains a real need for a balanced introductory book to give the range and feel of the subject. The author has been bold enough to attempt this in the limit of 125 pages.

The result is not entirely satisfactory. Experimental matters are dismissed so superficially that the reader will scarcely form any useful idea of what the techniques are like, and he is never made to come to grips with a spectrum, so that the problems of analysis must remain unreal. There is a discussion (pp. 24–58) of the theoretical basis of the subject which occupies a disproportionately large space, but which will yet be of small help to a beginner. The emphasis, too, will not meet with acceptance everywhere; this is laid on the measurement of wavelength, and there is little talk of intensities. Justice is scarcely done to the vast body of work on quantitative ultra-violet absorption spectroscopy.

The book was prompted by a sound idea, and there is some good stuff in it—good enough, indeed, to make one hopeful that a revised edition will approximate more closely to what is wanted. The price is high: the language sometimes distinctly odd.

R. F. Barrow

Introduction to Theoretical Mechanics

By Prof. Robert A. Becker. (International Series in Pure and Applied Physics.) Pp. xiii+420. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 57*s*. 6*d*.

THIS book provides a straightforward and extremely competent introduction to the subject of theoretical mechanics. It may be said roughly to cover the three years of an honours physics degree-course in Britain; it starts with a chapter mainly devoted to vector analysis, and leads, through the usual topics in mechanics, to subjects such as accelerated reference systems, motion of a rigid body in three dimensions, generalized co-ordinates and vibrating systems.

It is definitely a work for physicists. The physics of each problem is clearly stated, and the mathematics introduced is shown to be the most suitable for the purpose concerned; there is no mathematics for mathematics' sake. The practical nature of the book is emphasized by the provision of problems at the end of each chapter; these are carefully chosen to provide all grades of difficulty so that both the average and the good student can test their abilities on them. Altogether, the book can be recommended as a reliable, workmanlike and carefully presented introduction to theoretical mechanics.

MARINE SCIENCE IN THE PACIFIC AREA

THE growing needs of marine research have brought to the United Nations Educational, Scientific and Cultural Organization many appeals for help from a wide range of projects, and the Director-General has felt the need for an advisory committee. Having received the necessary authority from the General Conference of 1954, he discussed the usefulness of such a proposal with a representative group of oceanographers meeting in 1955 after the Food and Agriculture Organization meetings in Rome, and after consulting that body and the International Council of Scientific Unions, he nominated an Interim Advisory Committee, with nine members and provision for regular changes in membership. Clear emphasis was given to the need for good working relations with the United Nations and its Specialized Agencies, and with the international scientific unions and regional bodies which are concerned with oceanographic and fishery research.

The Interim Committee met for the first time during October 24–25 and, on the invitation of the Japanese Government, the meeting was held in the International House of Japan in Tokyo. Symposia on oceanic circulation bearing on the biological resources of the Pacific Ocean, oceanographic instruments and exchange of information were held just before the meeting, and these followed a regional gathering of representatives of marine laboratories and the sixth session of the Indo-Pacific Fisheries Council.

The Advisory Committee started with a general discussion of trends and progress in marine research; it is not easy to summarize this without the full record, but some of the main features can be outlined. It was emphasized that there is still plenty of room for exploratory and descriptive work, especially in the Indian and South Pacific Oceans; but there was also clear insistence that much more than this is needed before the scientific studies can be applied successfully to the practical problems. It was emphasized that the problems are now of such a calibre that they need the attention of physicists, mathematicians, chemists, biologists and geologists who have proved outstanding in their own fields, and it was considered that applications of recent advances in these sciences to the study of the oceans have already proved sufficiently rewarding to interest specialists in applying their ideas to the ocean.

In physical oceanography new techniques and the methods of mathematical physics are beginning to revolutionize our understanding of ocean currents and waves. In marine chemistry such advanced techniques as mass spectroscopy, radiochemistry, emission spectroscopy, chromatography and biological assay are adding fresh significance to studies of substances present in very small concentrations and doing much to further the study of biogeochemical cycles. In biology new applications of genetics, biochemistry, population dynamics, physiology and bacteriology have furthered problems of great importance in the sea, and it seems very desirable that they should go hand in hand with future work on taxonomy, life-histories, morphology, zoo-geography and ecology. There was, however, some feeling that progress in marine research might suffer if the detailed studies, especially some of those using marine animals, are made without keeping the wider problems of the sea, particularly those of the deep ocean, in mind. In submarine geology the techniques of geophysical exploration and the latest methods of physical and chemical analysis would have to be used, as well as echo sounders and the older methods, to study the morphology of the sea floor and the character of the sediments.

There was some general discussion on the kind of laboratory needed for marine research. No one seemed to have much enthusiasm for an international laboratory entirely dependent on contributions from a number of countries. One of the objections was that marine research cannot be planned so nicely that each country would feel that its own interests and problems were receiving a fair share of attention. The difficulties might be less if the programme included the short-term examination of a number of immediate problems, but it seemed very doubtful whether the atmosphere of a joint laboratory, which had to justify itself continually to a joint administration, could be conducive to long-term research. Even in fisheries research, where knowledge of the life-histories, growth-rates and natural fluctuations in numbers of the principal food fishes is of obvious importance, joint ownership had not proved itself very sympathetic to a systematic approach.

There seemed to be a general feeling that support from private funds was conducive to stability and freedom for research, and that there were real advantages in making a relatively modest start centred on some local enthusiasm, emphasizing one aspect, probably marine biology, with later expansion into the other fields as additional funds became available for staff, ships and shore facilities.

For the more developed countries, the Committee considered that progress depends to a large extent on national centres for the marine sciences, at least partly supported by government funds. It was maintained that recent experience has shown that such centres should include men with special training and interests in applied mathematics, theoretical and experimental physics and geophysics, chemistry (geochemistry, biochemistry and analytical chemistry), geology, meteorology and biology (both experimental and ecological). Although the growth and outlook of a new laboratory depend to a large extent on personalities and local conditions, it seems essential to employ more than a certain number of permanent scientists (probably about ten) and to provide for adequate support in facilities and technically trained assistance. There was a general feeling that the research centre should be closely associated with a university.

The need for better facilities for the study of the deep ocean was specially emphasized, and although fairly serious difficulties are foreseen, a study of the feasibility of operating an international research vessel, to work primarily in little-explored areas, was considered well worth while. It was argued that the marine sciences are a natural and invigorating field for international collaboration, and that there is much in the study of the seas and marine animals to enrich human life culturally as well as economically.

Although it was not the business of the Interim Committee to decide the position of a Unesco Advisory Committee on Marine Sciences in relation to other organizations, particularly the International Council of Scientific Unions and the Food and Agriculture Organization, the question was often mentioned and there seemed to be a general feeling that the new committee would do useful work without wasteful overlapping. None of the scientists seemed to think a precise definition was needed, since each authority must obviously interest itself in the work and aims of the others while arranging its own meetings, grants and other activities with its own primary object in mind. The Food and Agriculture Organization has a primary duty to see that the best practical use is made of new and established methods and knowledge to find more fish and improve the supply, and to achieve this it must further education in the less-developed countries and support research in more-advanced countries to find improved techniques and a more effective understanding of the basic biological and physical processes. The International Council of Scientific Unions is concerned primarily with the development of the science; and although it is interested in seeing that all countries share in new developments and advantages, it must concentrate on invigorating the efforts of the most successful scientists. Unesco also has to encourage the new advances as, for example, by its generous treatment of the scientific unions; but its primary concern is to spread the science and its cultural advantages as widely as possible, taking special care of the less-developed countries.

The need to ensure that the relatively small international funds available for furthering marine research are used most efficiently was always in the forefront of the deliberations. The expense of administration and travel was lamented, but the importance of using them as energetically as possible to communicate enthusiasm, ideas and results was fully recognized. There can be no doubt of the value of the meetings in Tokyo. There was a good representation of Japanese scientists, a fair number of representatives from other marine laboratories in the Far East and a few American and European scientists, including representatives of the U.S.S.R.

Marine Science in Japan

The International Directory of Oceanographers, published by the Allan Hancock Foundation, lists only 129 names for Japan as against 195 for the United Kingdom; but in view of the number of laboratories and ships devoted to marine research in Japan, it seems likely that a rather different method of selecting names was used. Among the research institutions are the Japanese Hydrographic Office, under the Maritime Safety Board, seven regional fishery laboratories, the Central Meteorological Office and its four subordinate marine observatories, the Tokyo University of Fisheries, the Disaster Prevention Research Institute in Kyoto University, the Transportation Technical Research Institute and Whale Research Institute, and a number of university faculties devoted to fisheries and geophysics. This is by no means a complete list, since active research is also being carried on in laboratories devoted to basic sciences such as the Institute of Chemical Research, Kyoto University, and many other university departments. They are assisted by eighty ships, not counting vessels less than 20 tons, and although these are not entirely devoted to research they are actively engaged fully or part time in oceanography.

Such exceptional interest in the sea can be explained only by Japan's need to use marine resources to the full, and to take the most effective safety measures she can against the hazards of the typhoons and submarine earthquakes by which she is continually threatened.

Much of the work in marine physics has been related to the needs of navigation, meteorology, coastal engineering and the fisheries. The Japanese say they made their first sounding in 1872; but they have now very extensive programmes of coastal and oceanic surveys being made with the most modern methods. One of the most detailed surveys, of the strait between Honshu and Hokkaido, was made with the help of a portable set of Decca Navigational Aid, and it is claimed that a horizontal accuracy of $\pm$ 10 metres was obtained as far off as fifty miles from the stations. They have made extensive studies of the marine sediments, and have located several coal- and oil-fields on the continental shelf. Tidal observations have been made at more than a thousand places, and a new 42-component Légé tide-predicting machine is being installed. Particular attention is paid to the tidal streams, and a number of types of ingenious continuously recording meters are in regular use. Wave recorders are being used for studies of coast erosion, and tide recorders for research on seismic surges (tsunami) and storm surges (takashio). The marine meteorological research is primarily aimed at better understanding of the processes of energy exchange between ocean and atmosphere, and prediction of the water temperature; but the Central Meteorological Observatory has biologists and chemists as well as physicists in its oceanographic section, and initiates studies of the distribution of microplankton and macroplankton in relation to the water masses as well as variation of sea conditions, current boundaries, etc.

The fisheries research is aimed primarily at finding and improving the exploitation of fishing grounds and attempting to foresee fluctuations in distribution and numbers of mackerel, sardine, squid, herring, salmon, shipjack, tunas and whales. The work includes extensive ecological surveys of spawning and nursery grounds, and detailed studies to improve the understanding of variations in the principal currents, particularly the Kuroshio and Oyashio. It includes research cruises to the Bering Sea and more than half-way across the Pacific Ocean.

As in other countries, there is no obvious or logical division between the basic and applied research; but there seems to be a tendency for the initiative in the basic work to be with the universities, though they do not lack active collaboration from the government and regional laboratories devoted to hydrographic, meteorological and fisheries research. In marine physics there are energetic studies of wave generation and propagation, beach currents and shore-line changes, and a co-operative programme between the oceanographers and the Shipbuilding Research Association has recently been commenced. Forecasting of waves and swell is being studied and special attention paid to conditions of dangerous wave interference associated with typhoons. Theoretical and observational research on long waves, seismic and storm surges includes studies of the effects of dispersion, reflexion and refraction. Natural oscillations in lakes, bays and harbours are being investigated in connexion with harbour con-

struction. Basic studies are being made of tidal oscillations, with particular attention to conditions in rivers, straits and shallow seas. A start has been made with studies of turbulence associated with the streams. Some experience has been gained in the use of electronic analogues. Statistical studies at the Earthquake Research Institute show that there is a tendency for the monthly mean sea-level to drop sharply before the large earthquakes.

Theoretical work on oceanic circulation presents many difficulties due to lack of information about actual velocities and mixing processes, and to the rapidly increasing complexity of the reasoning as the basic assumptions are made more and more realistic. The output of the Japanese workers in this field, largely owing to the influence of Prof. Hidaka, is enough to set ideas and conclusions running ahead of the observations and experiments. Marine research in Japan is likely to become remarkably productive if the theoretical workers are more actively helped and invigorated by the physicists, engineers and ships. There is a good measure of co-operation, but the practical facilities voted for attacks on obvious practical problems have to be devoted largely to methods which have been proved. This often means that the theoretical workers have to spend too long with pen and paper before they can put new ideas to work, and have their work stimulated, intensified and improved by practice and closer inquiry. This is a universal problem, but anyone attempting to survey marine science in Japan cannot fail to be impressed by the great wealth of observations, some of which have to be dealt with in fairly general terms, and by a similar wealth of theoretical work, some of which has to seek rather hard for the measurements that it believes most significant. The Japanese scientists lose no opportunity of checking measurements with hydrodynamical theory, and are well aware of the need to devote as much of the practical effort as possible to basic studies; but they might be able to do more if the responsibilities and burden of some of the practical requirements were shared by academic and technical workers in a laboratory in which both were well represented.

Some twenty Japanese scientists are making active contributions to the chemistry of the sea, including the development of new analytical methods and studies of variations in oxygen, carbon dioxide, nitrogen, phosphorus and other nutrients in relation to productivity, water movements and sediments. Attention is being paid to the elements in minor concentrations and to the geochemical implications of the work. Measurements of radioactivity near Bikini atoll have been used for studies of diffusion.

Japan has twenty marine biological stations, each with a staff of two to five full-time research workers as well as technical assistants and facilities for working in coastal waters. They lie between 33° and 43° N. over a very wide range of exposure and water conditions. In some the investigations are mainly physiological, without much immediate application to ecological and oceanographic problems. The local faunas are described, though not as completely as for some European laboratories. For work in the open ocean they rely on co-operation from the hydrographic, meteorological and fisheries laboratories, and active work is being done on productivity, indicator species, and the general character of regional faunas in relation to oceanographic factors. They emphasize the need for more taxonomic studies.

The Japanese instrument makers arranged an exhibition in connexion with the Unesco meetings, and it was apparent that they are keeping pace with new developments in marine research.

The International House of Japan was an ideal house for the meetings. The lecture hall will seat two hundred, and the dining hall and adjacent lounge could be combined to accommodate about the same number. There are forty-two bedrooms, single and double, and the service and meals were excellent. It is a non-profit organization, made possible by £100,000 collected in Japan and a grant of £125,000 capital expenditure and £25,000 a year for the first five years from the Rockefeller Foundation. It was formally opened in June 1955, and its activities aim primarily at promoting and sponsoring the international exchange and co-operation of intellectual leaders and creative artists, though some of its programmes are planned for students and the general public. The Japanese writer and lawyer Shigeharu Matsumoto is its managing director.

G. E. R. Deacon

RESISTANCE OF INSECTS TO INSECTICIDES

On January 9 the Association of Applied Biologists and the Society of Chemical Industry held a joint symposium in London on the subject of the resistance of insects to insecticides. The morning session was devoted to a discussion of the changes in resistance that can occur naturally before any kind of selection has occurred. The afternoon session was chiefly concerned with a discussion of the resistance that may develop following the use of insecticides.

The first paper, by C. Potter, dealt with the variations in resistance to insecticides that normally occur throughout the life-cycle of an insect and of the effect that differences in nutrition may have on resistance. It was pointed out that, in practice, insecticides are usually applied to kill a particular instar of a pest and it is important to choose the most susceptible instar for attack. Furthermore, since there can be variation of resistance with the age of the instar, detailed knowledge of the extent of these changes is desirable if control measures are to be put on a rational basis. Examples were then given to show the extent of the changes in resistance to insecticides that can occur throughout the life-cycle of an insect and also those that can occur during the development of a single instar. The changes throughout the life-cycle may be large; in one example quoted, it was more than 250 times. Smaller changes are found to occur within the instar, but even these can be appreciable, an example of a difference of more than sixteen times being given.

The examples given by Dr. Potter served to show that the extent and direction of the changes in resistance depend on the insecticide used, the species of insect and the conditions of treatment. It follows

from this that not only may the absolute toxicity of any one insecticide differ with the stage of development, but also that the relative toxicity of any two insecticides is likely to differ also. There appears to be no information on the reasons for the differences in resistance between instars, and they are likely to be complex. Differences in resistance within an instar have been correlated with morphological and physiological changes that occur during its development, but these changes are not necessarily the cause of the differences. Examples were given to prove that the diet of the insect may affect its resistance to insecticide. This was shown to happen both by changing the constitution of artificial diets and by changing the host plants of insects that feed on living plants. The amount of food administered and the period when it was administered were also shown to affect resistance.

A. H. McIntosh then discussed the effect of temperature on the toxicity of insecticides. He stated that a change in the temperature at which insects are kept after treatment with poison nearly always affects the kill. If the kill increases with temperature, the temperature coefficient of kill is positive, and vice versa. In contact tests on grain beetles, the size of the temperature coefficient depends on the particle size used if the poison is a solid. If the temperature coefficient is negative, it is always bigger for colloid than for crystals; this happens with DDT and some of its analogues, rotenone and endrin. But if the temperature coefficient is positive, it may be bigger for colloid than for crystals, as with dieldrin, or bigger for crystals than colloid, as with 2-bromomercurithiophen.

The time elapsing between treatment of insects and counts of kill may sometimes affect the size and sign of the temperature coefficient. Thus, the temperature coefficient of dieldrin by injection into mealworms did not change as time passed (one to four days); but with rotenone the coefficient was negative if counts of kill were made up to about a day and a half after treatment, and after this it was positive. At the higher temperature, the percentage kill increased as time passed, but at the lower temperature the insects recovered from the effects of rotenone. The size and sign of the temperature coefficient may also depend on the dose, the method of application, the insect species and the range of temperatures used. The most that can be said about any one poison is that its temperature coefficient is usually positive or negative, as the case may be. Differences in temperature are certainly one cause of differences in both relative and absolute toxicities found by different workers.

K. F. Goodwin-Bailey then read a paper on behalf of J. M. Holborn on the susceptibility to insecticides of laboratory cultures of an insect species. The results of tests of the comparative resistance of strains of *Tribolium castaneum* (the rust-red flour beetle) and of strains of *Calandra granaria* (the granary weevil) were described. None of these strains had been exposed previously to insecticides, yet they showed consistent differences in resistance to the test poisons. A laboratory strain of *C. granaria* was found to be between three and a half and six and a half times as susceptible to pyrethrum powders as a wild strain. There was little difference in susceptibility when pyrethrins synergized with piperonyl butoxide were used. Several strains of *T. castaneum* developed from cultures from different laboratories were tested against γ-BHC, the pyrethrins and the pyrethrins synergized with piperonyl butoxide. The strain showed marked differences in susceptibility to γ-BHC and the pyrethrins, but the differences were less marked with the synergized pyrethrins.

The most resistant strain was four times as resistant to γ-BHC and three times as resistant to the pyrethrins as the least resistant strain. There is evidence that these natural differences were inherited through at least six generations. The differences in susceptibility found are thought to be due to differences in vigour. The results also show that the factor of synergism can differ greatly with the different strains. With the species examined, the synergist appears to be most effective against the most resistant strains, thus tending to diminish the differences found with the pyrethrins alone. The data presented in this paper provide evidence that considerable differences in resistance to insecticides can exist between strains of the same species, before any treatment with a poison has taken place; that is, that insecticide resistance is not always acquired by selection.

The first paper in the afternoon was read by J. R. Busvine, who discussed the occurrence and status of insecticide-resistant strains. He listed twenty-one species recorded since 1940 as having insecticide-resistant strains in the field. Only those records were listed which at the same time were substantiated with good supporting evidence for the existence of insecticide resistance. The criteria to be adopted in judging whether or not a resistant strain had been produced in the field were then discussed, and it was pointed out that the factors of natural high resistance, faulty insecticide or inefficient application, the elimination of parasites and predators and natural fluctuations in the insect population, should first be excluded. These factors make the field assessment of resistance difficult, and it should therefore be confirmed in the laboratory by a quantitative comparison with insects of the same species that have not been exposed to an insecticide.

The necessity for adequate standardization of the method of assessment of resistance was stressed, since errors can occur due to lack of standardization of the insect material, and different results may be given by varying the method of test. In general, high resistance is associated with flat probit/regression lines. The probit lines for resistant strains are nearly always flatter than for normal strains. Where two techniques of measurement are used, one may show a bigger difference between resistant and normal than the other; it generally occurs that the technique showing the bigger difference has the flatter probit line.

Dr. Busvine then considered the types of resistance that occur and concluded that the more important forms of resistance which result in the failure of control measures are characteristically specific to one type of insecticide. The grouping of the insecticides into types on this basis may indicate that they have a similar mode of action. The biochemical basis of resistance has been studied by some workers, and it has been shown that resistant strains have an increased capacity to detoxify DDT, although this alone is not sufficient to account for the degree of resistance that occurs. It was pointed out that there is some evidence of increased metabolism of the insecticide with strains resistant to γ-BHC, chlordane and toxaphene. Studies on the genetical bases of resistance have yielded very conflicting results, and there appears to be no general agreement. Dr. Busvine ended his talk with a plea for further research on this subject.

The next speaker, F. R. Bradbury, then gave a paper on the absorption and metabolism of benzene hexachloride in normal and resistant houseflies. The pick-up and absorption of vapours of γ-BHC and of its non-toxic α-, β- and δ-isomers by the housefly *Musca domestica* have been studied by confining susceptible and resistant strains over treated filter papers; labelling with carbon-14 and chlorine-36 has facilitated analysis. The general picture of resistance to γ-BHC deduced from the data broadly parallels that currently held for DDT. Resistant flies pick up and absorb less poison and perform a more rapid conversion to excretable metabolites with both the toxic and non-toxic isomers of BHC and, probably, there are differences in the distribution of the poison in the bodies of the susceptible and resistant strains. Resistant strains also convert a greater percentage of the absorbed dose in the earlier stages of storage.

By reversed-phase chromatography it has been established that the carbon tetrachloride extracts of flies treated with γ- and δ-BHC contain mainly unchanged BHC. No dehydrochlorination products have been detected in these extracts, and evidence that metabolism is accompanied by dechlorination was presented. The problem of the identification of the metabolic products is complex. In the metabolism of the four common isomers of BHC, water-soluble compounds are produced most readily from the α- and γ-isomers and much less readily from the δ- and β-forms. Two-dimensional chromatography has revealed eleven well-defined compounds from both γ- and α-BHC; these have not been identified, but there is evidence from paper electrophoresis that eight of the eleven compounds from these two stereoisomers are the same. It is unlikely that all the metabolites are trichlorobenzene derivatives, and it is possible that benzene derivatives (by dechlorination) are intermediate stages in the production of some of these metabolites. Comparative tests on a number of insect species have shown that even normal houseflies are exceptionally able to convert γ-BHC to excretable, water-soluble metabolites, and this factor may predispose this insect to the acquisition of insecticide resistance.

It is concluded that the reduced absorption and the increased amount of metabolism are not alone sufficient to explain the increased resistance. These two factors give at the most a sixfold difference in BHC content between normal and resistant flies, while resistance has increased by a factor of one hundred. However, it is possible that a combination of reduced absorption, increased metabolism and redistribution of the poison in the insect might provide the explanation.

The concluding paper in the afternoon was given by F. P. W. Winteringham on biochemical factors in the natural and acquired tolerance of insects to insecticides. It was pointed out that, when an insecticide is applied to an insect, it may be attacked by the tissue enzymes with the formation of metabolites which may be more or less toxic than the insecticide itself. An example where the metabolite is more toxic than the original chemical is parathion, which is a poor inhibitor of cholinesterase. Parathion is known to be oxidized by the insect *in vivo* to the oxygen analogue paraoxon, which is a potent inhibitor of cholinesterase. Similarly, it has been established that 'Schradan' becomes oxidized to a monophosphoramide oxide or a compound very much like it. The process occurring in these two examples might be referred to as toxication. The conversion of insecticides to harmless metabolites or detoxification has been demonstrated with DDT and BHC, particularly with insects resistant to these poisons. It has now also been established that the pyrethroids undergo detoxification in the adult housefly, and there is some evidence that the detoxification process is not one of simple hydrolysis.

The increased detoxification of poisons by resistant insects when compared with normal insects might be either a consequence or a cause of the insects' survival, there being evidence for and against either possibility. Extensive detoxification may occur in normal insect strains, and this must be a factor in their normal tolerance. Detoxification may be inhibited by the presence of certain adjuvants applied simultaneously with the insecticide. A complete understanding of the DDT-resistance problem implies a better understanding of DDT action *in vivo*. Recent work indicates that DDT may, in normal strains of insect, interfere with the oxidative formation of the vital tissue substance adenosine triphosphate. The interference was not observed in a resistant strain, and it may therefore be an additional biochemical factor in DDT-resistance mechanism.

When the evidence provided by all the papers given at the symposium is considered, it appears that results are steadily being accumulated on the changes of resistance that occur naturally and that are produced by the application of an insecticide. However, little progress has, as yet, been made in demonstrating the causes for the differences in resistance that are found, and this work is severely handicapped by lack of knowledge of the mode of action of insecticides.

THE 74-IN. REFLECTOR OF THE COMMONWEALTH OBSERVATORY, MOUNT STROMLO, CANBERRA

EARLY in 1947, the Commonwealth Astronomer, Prof. R. v. d. R. Woolley, supported by the then Astronomer Royal, Sir Harold Spencer Jones, and the board of visitors of the Commonwealth Observatory at Canberra, laid before the Minister for the Interior, the Hon. H. V. Johnson, proposals relating to the establishment of a large reflector at Mount Stromlo.

Among the arguments advanced for the placing of such a telescope at Mount Stromlo was the fact that telescopes of 72-in. aperture or more are to be found almost exclusively in the northern hemisphere. Even at the present time, with the Stromlo instrument operating, the situation is still unbalanced, for there are two such instruments in the south as against nine (including those under construction) in the north.

Cabinet approval was given for the construction of the instrument, and in 1948 an order for a 74-in. telescope complete with building and dome was

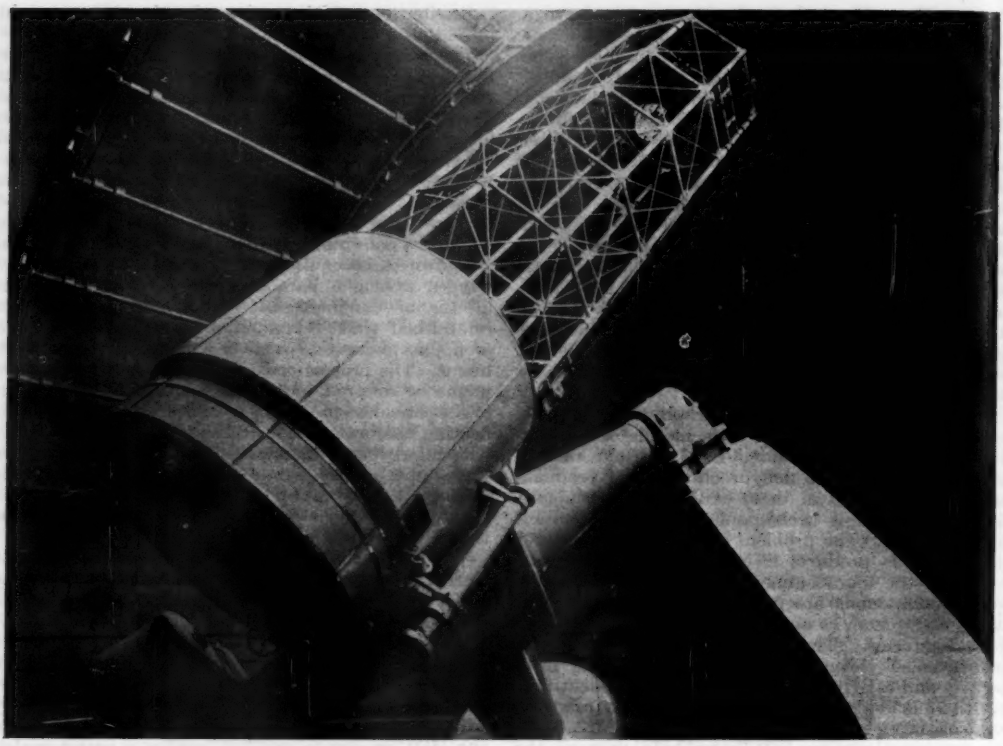

Fig. 1. The 74-in. reflector at Mount Stromlo Observatory. By courtesy of the News and Information Bureau, Department of the Interior, Commonwealth of Australia

placed with the firm of Sir Howard Grubb Parsons, England. The mounting was finished early in 1951 and, after display in the Festival of Britain, was sent to Mount Stromlo. By early 1954 all parts of the telescope and dome were delivered with the exception of the aluminizing plant.

The telescope was formally opened by His Excellency the Governor-General, Sir William Slim, on November 8, 1955. The opening ceremony was held in the dome with the then Minister for the Interior, the Hon. W. S. Kent Hughes, in the chair. Mr. Kent Hughes referred to the labours of the Commonwealth Astronomer in initiating the project and wished him every success in taking up his new post as Astronomer Royal at the Royal Greenwich Observatory, Herstmonceux. Sir William Slim concluded his address by pressing a button, which caused the shutters of the dome to open.

Prof. Woolley then demonstrated the operation of the telescope to an audience of nearly two hundred people, representatives of academic, scientific and departmental activities in Canberra.

The total weight of the moving parts of the new equipment is 40 tons. The main mirror is 74 in. in diameter, 11¼ in. thick, and weighs 4,000 lb. The building and dome housing the new telescope provide a controlled ventilation system designed to keep the interior of the dome at as near to night temperature as possible during the day. The dome weighs about 100 tons and can move at a speed of one revolution in five minutes. The rotation of the dome allows any part of the sky to be viewed.

The instrument is designed for use at the Newtonian, Cassegrainian and coudé foci with the respective aperture ratios of $f/5$, $f/8$ and $f/28$. Photographs have also been made at the prime focus for testing purposes, but regular operation in this position is not contemplated. The instrument is arranged on an English-type mounting and access to the Newtonian focus is effected by a platform which moves up and down the opening of the 62-ft. diameter dome.

OBITUARIES

Dr. Sunder Lal Hora

Dr. Sunder Lal Hora, well known to many zoologists in Great Britain, died suddenly on December 8; he was due to retire from his post as director of the Zoological Survey of India this coming June. Hora was born at Hafiazabad in the Punjab in 1896 and educated at the Anglo-Sanskrit High School at Jullundur. Thence he went to Government College, Lahore, where he came under the influence of Prof. John Stevenson and had a distinguished career as a student, obtaining the M.Sc., in part for work on the "Fish of Lahore", and receiving the Maclagan Gold Medal and Purse of the University of Punjab. The same year, 1919, he joined the Zoological Survey of India as a research scholar and less than two years later was appointed to the permanent staff. It was here that he became closely associated with Dr. Nelson

Annandale, of whose help and inspiration he always spoke with affection. In this service he spent the rest of his life, with the exception of 1942–47, when he was director of fisheries for Bengal, returning to the Survey as its director in 1947. He was awarded the D.Sc. of the University of Punjab in 1922 and of Edinburgh in 1928.

Dr. Hora was an indefatigable and careful worker and his many publications cover various fields. He was primarily a systematic ichthyologist and the admitted authority on the freshwater fishes of India and adjacent lands. This statement without qualification could convey a false impression of his breadth of outlook. A number of his systematic papers contain bionomic and ecological observations. The latter aspect induced him to consider the adaptation and the evolution of the adaptive mechanisms of animals to the severe conditions in torrential streams, and his best-known publication in this field (*Trans. Roy. Soc.*, 1930) is mainly devoted to insects.

In trying to comprehend the pattern of the distribution of freshwater fishes in India and Malaya, Dr. Hora was led to consider the past geological history of these areas, and particularly that of the changing river systems brought about by Himalayan tectonic movements, and he put forward an ingenious explanation known as Hora's Satpura hypothesis. From an early stage he became interested in fisheries and means of increasing their efficiency with due regard to conservation. Later, he tackled the pond culture of fish with the view of increasing the food supply. The work and enthusiasm he put into this led to his being invited to open a discussion on the subject at the United Nations Conference at Lake Success in 1949. As fisheries consultant to the Food and Agriculture Organization he recently completed a "Handbook on Tropical Fish Culture".

Dr. Hora's command of Sanskrit enabled him to assess the knowledge of fish and fisheries possessed by the ancient Hindus and so make a significant contribution to the history of Indian science.

Dr. Hora was very active outside his own post and held important positions in various scientific societies and organizations. In recognition of his work he received a number of awards and honours, both in his own country and abroad; but he remained a most approachable and companionable man who willingly placed his knowledge at the disposal of others and, in particular, younger workers, many of whom he encouraged at critical stages in their careers. With his death India has lost a distinguished zoologist and loyal son, and many zoologists in other parts of the world will mourn a friend.

C. H. O'Donoghue

Sunder Lal Hora's research career was dominated by the materials and concepts he had inherited from Nelson Annandale, and he succeeded in creating new vistas of biological discovery in India. He took Indian ichthyology back to ancient history, prehistory and palæontology, and forwards to a systematized historical understanding continuously related to the material and cultural welfare of the Indian people. His emphasis throughout has been on relationships: from the immediate relationships he described to the larger relations between science, the humanities and politics.

He believed in generalizations based on the growth of intensive specialization into a many-branched unity.

At home he was a kindly patriarch, sometimes looking askance, but tolerantly, at the departures from Punjabi custom of his children; for him the day started with the prayers he had learned in childhood. He was humble, affectionate, considerate, addicted to tabulating routines which never reached the level of work-disciplines, eager for new experiences (he had travelled extensively in most countries), quick to laugh, and quite unable to control his passion for shop talk. On one occasion in London in the autumn of 1953, when he had talked zoology before, through and after dinner, Mrs. Hora whispered to a friend, with a wealth of loving understanding in her voice, "It is always so—nothing but fish!"

He lived a full life, with many sorrows and satisfactions, but remained astonishingly unsophisticated. After his first heart attack, he compromised with decadence by rising at 5.30 a.m. instead of earlier. He could not adjust himself to slowing down, and when I stayed with him in Calcutta a year ago, he made it clear that he would rather die at work than live as a semi-invalid. He died as he wished. He collapsed while presiding over a meeting of the Asiatic Society, but not before calling upon a member to take the chair. It was, characteristically, the last public gesture of a man whose life was distinguished by service and integrity.

Cedric Dover

Mr. Frank C. Willcocks

In a few years time Frank Willcocks may become one of those "that have no remembrance", because of his own modesty, and because of his isolation for thirty years in Egypt, yet those of us who had been his colleagues recognized his possession of 'the Darwin touch'.

The influence of Theobald at Wye diverted his intention from farming to entomology, and so to an appointment with the Khedivial Agricultural Society when its eight-room laboratory was founded in 1904, a chemist and a botanist being his colleagues. Within two years he was able to outline the three major pests of cotton in a hundred pages of the Society's Year-book, and this succinct account by a non-graduate student aged twenty-four is still a standard reference.

He remained with the Society until 1930, designing and founding its Cotton Museum as a side-issue, then retired to Bournemouth, whence he moved after the death of his French wife to a bungalow in the woods near Battle. The toil of struggle with his orchard and garden, workshop and housekeeping, lonely except for his friends the cats, led him at last to move to the home of a niece in Gloucester, where he died unexpectedly only a few weeks later on December 18 at the age of seventy-two.

The introduction to his last publication in 1937 (the third volume of "Insect and Related Pests of Egypt") gives a clear impression of his sincerity and quiet wit, his humility towards the specialization of his juniors, and his gratitude for help by lesser men. He was a scientist in grain, the infinite capacity for taking pains being combined with a wide view across the field of his economic problems; he was a pioneer. In that last volume he devotes particular attention to one of his favourite insects, treating the mole-crickets almost affectionately, alternating between the ingenious additions to our knowledge of them which he made and his repeated emphasis on knowledge about them still to be sought. His dealings

with the velvety strength of *Gryllotalpa*, burrowing, swimming and flying, showed him to have been a great naturalist.

Willcocks took occasion to investigate patiently some unique opportunities. The invasion of a new scale-insect which destroyed the Lebbek avenues of Cairo was the first of them. Another was the arrival in Egypt of the pink boll-worm, which quickly became the major pest of cotton for many years; arising out of his studies about its queer resting-stage in the seed, he invented the heat-treatment which has for decades been applied as compulsory routine at every ginnery in the country; the credit went elsewhere. His quiet enthusiasm enlisted many willing amateur helpers before professional entomologists became abundant, and his reputation was in no way diminished when the newcomers found that they could accept his fundamental observations.

The Cotton Museum exercised his ingenuity, and his craftsmanship produced some noteworthy exhibits in collaboration with his wife and his artist brother-in-law, A. Morel; there were some witty private fantasies as well. Writing results was a painful necessity, and because his publications were made in Egypt they are little known elsewhere. Unfortunately the three volumes already mentioned weigh more than half a stone apiece, with three-inch page margins, so that their unwieldiness restricts their use.

Willcocks leaves memories of gentle pessimism; of devotion to his friends, whether human, feline or even invertebrate; of industry in spite of recurrent invalidism. It must be a matter for regret that Britain found no means for making use of the latter half of a life from which Egypt had profited so much.

W. Lawrence Balls

NEWS and VIEWS

Photographic Science: Dr. C. E. K. Mees, F.R.S.

By the retirement of Dr. Kenneth Mees from his position as vice-president in charge of research of the Eastman Kodak Company, industry has lost one of its foremost research directors. While many have the satisfaction of looking back on widely applied technical improvements for which they have been responsible, few can claim to have altered the whole aspect of an industry; Mees is one of them. At University College, Sir William Ramsey dissuaded Mees from an academic career, and in 1906 he joined the firm of Wratten and Wainwright, Ltd., of Croydon, as partner and joint managing director—at a salary of £3 per week! At that time the photographic industry depended largely on empiricism for its advance, and this appointment presented a wonderful opportunity to a trained scientist of exceptional ability. Mees was not slow to take full advantage; he was the first to market panchromatic materials, and by proper application of spectrophotometry was able to produce a comprehensive series of light filters (Wratten filters) which were the first commercially available products in this field. At this time industrial research laboratories were rare; but with characteristic foresight George Eastman decided to establish one at the Eastman Kodak Company's plant at Rochester, N.Y. Mees was invited to organize this development; but he was reluctant to leave his firm, so Eastman purchased Wratten and Wainwright, Ltd., and in 1912 Mees went to the United States to commence his duties. Since that date the work of the laboratory has covered both fundamental and applied research, and has not been confined to subjects of immediate connexion with photography.

In a special division of the laboratories which Mees established for research on photographic emulsions, much of the early development work leading to the great advances in photographic materials has been carried out. Of special importance for science was the working out of a wide range of plates and films for spectrographers and astronomers. Among the other notable contributions to photography made by Kodak during the period when Mees was director of the Research Laboratories were the introduction of panchromatic materials, of 16-mm. (and later 8-mm.) Cine Kodak film and equipment in 1923, and 'Kodachrome' film in 1935. Other activities include the establishment in 1918 of a department for the manufacture of synthetic organic compounds to replace German supplies, which has now become the Eastman Organic Chemicals, and work on molecular distillation, which was applied successfully to the extraction of vitamins from cod liver oil and has resulted in Distillation Products, Inc. Mees's books on photography culminated in his "Theory of the Photographic Process", published in 1942 and completely revised in 1954. His wide interests are reflected in "The Organization of Industrial Scientific Research", written in collaboration with J. A. Leermakers; but his breadth of vision is best illustrated by his philosophical discussion of the history of science in relation to world history—"The Path of Science". He was elected an Honorary Fellow of the Royal Photographic Society in 1921, and received the Progress Medal of this Society in 1913 and again in 1953. In 1939 he was elected a Fellow of the Royal Society, and in 1950, after he became an American citizen, a member of the U.S. National Academy of Sciences.

Dr. C. J. Staud

Dr. Cyril J. Staud now succeeds Dr. Mees as vice-president in charge of research and development, Eastman Kodak. Staud graduated at the University of Rochester, N.Y., and obtained a Ph.D. degree at the Massachusetts Institute of Technology. He joined the Kodak Research Laboratories in 1924, where his ability gained for him positions of increasing responsibility. In 1931 he was appointed superintendent of emulsion research, and was appointed director of the Research Laboratories in 1947. His energies have been devoted to the internal organization of the laboratories, so that he is not as well known outside the firm as his achievements would warrant. He has an astonishing grasp of the details of the wide activities of the Laboratories, and is outstanding in organizing and inspiring effective and enthusiastic team-work. His managerial skill is supplemented by a keenly inventive mind, and he has been responsible for many of the Company's scientific achievements. Although Dr. Mees's retirement is a sad loss to the organization, and to industry generally, the research activities of Eastman Kodak have been left in capable hands.

Progress Medal of the Royal Photographic Society : Dr. J. D. Kendall

THE Silver Progress Medal of the Royal Photographic Society has been awarded to Dr. J. D. Kendall, head of the Renwick Laboratory of Ilford, Ltd., in recognition of his distinguished contributions to research in the chemistry of photographic processes and materials. Dr. Kendall is known for his work in relation to photographic emulsion sensitizers, emulsion stabilizers, colour couplers, developing agents and desensitizers. His discovery, some twenty years ago, of particular *p*-dialkylaminobenzylidene derivatives of compounds having a reactive methylene group activated by carbonyl (the merocyanines) as efficient optical sensitizers for emulsions, was a starting-point for advances of considerable consequence in emulsion technology. In 1935 he proposed an original theoretical principle for relating the chemical structure of sensitizers, desensitizers and developing agents to their respective properties, and his name is now linked with those of Andresen and Lumière in the 'Andresen–Lumière–Kendall rules' for photographic developing agents. Dr. Kendall's relatively recent discovery of 1-phenyl-3-pyrazolidone (phenidone) as a developing agent has led to greatly improved commercial developers and has also initiated a great deal of research on superadditivity phenomena in photographic laboratories throughout the world. Even more recently (1954) he has described, in collaboration with G. F. Duffin, a new class of optical sensitizers, namely, the iminazolenine cyanines. The Progress Medal was instituted in 1878, and this is the forty-fourth such award, twenty-two being to persons of foreign nationality ; it is awarded for any invention, research, publication or exhibition which leads to an important advance in photography.

British Broadcasting Corporation : Miss Mary Somerville, O.B.E.

WITH the retirement in January of Miss Mary Somerville from the B.B.C., one of the links with the pioneering days of *2LO* has been broken. Miss Somerville joined the B.B.C. in 1925 as assistant to the then educational director, J. C. Stobart, having been attracted to the new field of intellectual adventure through the broadcasts of Sir Walford Davies. Within four years she had taken full charge of the embryonic Schools Department, and imbued by a strong sense of educational purpose, in the eighteen years of her active direction of this Department she carved out a unique place for this activity of the B.B.C. in the educational history of our time ; and this in the face of considerable resistance from the vested interests of the essentially conservative educational world. In 1947 she toured the Commonwealth and on her return became assistant controller of Talks Division, thus entering a field where she could to an even greater extent explore the radio medium as a means of communication. Three years later she took over one of the toughest assignments in the whole B.B.C. organization, that of full controller of Talks Division, and as such became the Corporation's first and only woman controller. With the whole of the Corporation's Talks output under her control, the world of science was not the least of her interests, and the present position of the B.B.C.'s science talks owes not a little to her sympathetic understanding of the problems that face the producer who is presenting science to a mass audience.

Mr. John Green

THE new controller of talks, Mr. John Green, also had connexions with science, if in the applied field, namely, agriculture. Mr. Green comes from a Gloucestershire landowning family. He went up to Cambridge, where he was President of the Union, and was afterwards called to the Bar. In 1934, however, he joined the B.B.C. and specialized in the production of agricultural talks, being the Corporation's agricultural liaison officer until he became Miss Somerville's chief assistant a number of years ago. Thus the new controller has risen from the ranks, as it were ; he is familiar with the professional problems concerned with talks production and sees in the producer a public servant with a valuable part to play in bridging the gap between those who have something to say and those who are prepared to listen.

British Iron and Steel Research Association : Dr. J. Pearson

THE British Iron and Steel Research Association has appointed Dr. J. Pearson as assistant director of research, to assume such duties as are delegated to him by the director, Sir Charles Goodeve ; Dr. Pearson will continue his present duties as head of the Steelmaking Division and Chemistry Department of the Association. After graduating from the University of London in 1933, Dr. Pearson did some research in organic chemistry, and then joined the Research Department of Tube Investments, Ltd., to carry out work in connexion with the manufacture of steel tubes and allied products. During 1937–46 he was employed in the explosives branch of the Armament Research Department, Ministry of Supply, and obtained his Ph.D. in 1946 for research work on the polarography of organic compounds. After the Second World War he joined the British Iron and Steel Research Association as head of the Chemistry Section of the Swansea laboratories, where he was largely concerned with problems on the disposal of spent pickle liquor. He was appointed head of the Chemistry Department in 1950, assuming the additional duty of head of the Steelmaking Division four years later.

Nuffield Foundation Awards in Dentistry, Biology and the Social Sciences

THE Nuffield Foundation is offering a number of fellowships, scholarships and bursaries in the fields of dentistry, biology and the social sciences. The fellowships for dentistry are for persons, aged 25–35 years, with dental qualifications to receive additional training in pure and applied science so as to fit them for an academic career in dentistry, and also to enable graduates in medicine and science to receive training (not necessarily for a registrable dental qualification) so as to undertake teaching and fundamental research on dental health and disease. (It is to be noted that in past years few applications have been made by those eligible in the latter category.) The fellowships are worth £500–800 a year for one to three years, and applications must be received by March 1. The dental scholarships, normally for one year only, are for students at university dental schools in the United Kingdom and cover tuition fees and a subsistence allowance of not more than £200 ; applications must be received by June 30. The Foundation's scholarships and bursaries in biology and the social sciences are for graduates of British universities, preferably within the age-group 22–35 years. The

awards in biology are for graduates in physics, chemistry, mathematics or engineering to receive such training in biology as will enable them to undertake research and teaching in the biological sciences in the United Kingdom. The scholarships, which are for those with postgraduate (non-biological) research experience, are worth £500–600 a year, and the bursaries £350 a year; in each case, fees, a marriage allowance of £50 a year and a family allowance of £50 per child will be paid. Applications must be received by April 1. The awards for social sciences are similar to those for biology, except that applications must be received by May 1, and the holder may have a degree in any academic subject other than the social sciences, psychology or the social sciences; subjects suitable for study by holders are political science, social psychology, anthropology, social statistics and sociology generally (but not economics). Applications for all these awards, and further information, can be obtained from the Secretary, Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1.

Industry and Nuclear Power in Britain

Questioned in the House of Commons on February 15 as to the Government's policy regarding the utilization by private firms of technical information on the industrial applications of nuclear power, the Lord Privy Seal, Mr. R. A. Butler, stated that it is the policy of the Atomic Energy Authority to encourage access by private firms to such information in order that industry may participate more fully in these important new developments. Steps are being taken to ensure that firms are not enabled to obtain exclusive rights on the basis of information supplied by the Atomic Energy Authority. In reply to further questions, Mr. Butler said he would discuss with the Minister of Fuel and Power, Mr. Aubrey Jones, the question of letting the House have the maximum information which it is in the public interest to disclose on this new phase in the relationship between the State and private industry on Mr. Aubrey Jones's early return to Britain.

Electronic Computers in Molecular Quantum Mechanics

The importance attached to the use of modern electronic computers in molecular quantum mechanics has been stressed in an International Conference held in Texas during December last. A resolution was passed unanimously, directing attention to the impressive results already obtained by high-speed computers in the calculation of molecular and crystal properties, and claiming that these properties are of extreme importance in chemistry, physics and biology. The resolution goes on to note that "progress of this work is greatly hampered by the fact that, due to their great cost, high-speed computers are unavailable to most scientists in this field"; and therefore it "recommends that governments, industries, foundations and private philanthropists give special attention to the problem of providing more high-speed computing facilities for use in molecular problems". Copies of the complete document are being sent to government and other scientific agencies in Britain, the United States and elsewhere.

This matter is highly important so far as Britain is concerned. It is believed that the University Grants Committee contemplates the provision of a limited number of these computers during the next quinquennium. But it would be a great pity if the number is unrealistically small. For, as Prof. D. R. Hartree and others have pointed out, electronic computers have entirely changed the kind of problem (such as the structure of vitamin B_{12} or a single protein molecule) which can be attacked successfully. As things are now, certain calculations have to be sent from Britain to the United States, since they cannot be dealt with adequately in British universities. One American firm alone expects to have nearly two thousand large computers in use at the end of another eighteen months or so. It is imperative that universities in Britain—and other institutions—should have calculating facilities which such machines alone can provide.

Artificial Rain-making in India

A symposium on artificial rain was held in India in February 1953 under the joint auspices of the Atmospheric Research Committee, Council of Scientific and Industrial Research, and the India Meteorological Department, the purpose of the symposium being to review the present status of rain-making operations, to discuss recent progress and to make recommendations for extending research in India on cloud physics. The proceedings have now been published (pp. 148. New Delhi: C.S.I.R., 1955). Of the twelve papers, six are concerned with the formation and physical characteristics of clouds in different parts of India. It appears that the release of showers by the coalescence of water-drops in non-freezing clouds is a common occurrence, and there was some discussion on the possibilities of artificially stimulating this mechanism by spraying the clouds with water droplets. It was concluded that, in India, the possibilities of producing economically significant quantities of rain by artificial seeding techniques are rather limited, largely because of the low frequency of cloudy days without rain in dry areas. In a long paper, Banerji and Mukherji describe their laboratory studies on nucleation and condensation, and also some cloud-seeding experiments which they have carried out near Calcutta. Hydrogen-filled balloons were used for releasing either dry ice, a spray of cold water or a charge of gunpowder impregnated with silver iodide at a predetermined altitude. Unfortunately, the physical reasoning used by these authors is not always sound, and their field experiments, although showing commendable enterprise, were not well conceived. Their observational techniques were also inadequate for a proper assessment of the results. A number of workers gave sober appraisals of the present status of rain-making trials in other countries and very properly stressed the need for more fundamental research in cloud physics and the training of more scientists in this field. The principal outcome of the meeting was a recommendation to the effect that a cloud physics research unit be set up to undertake fundamental research, and a rain research unit be established having aircraft and radar facilities for planning and conducting field experiments. These proposals show not only enthusiasm but also an appreciation of the importance and magnitude of the problem. India has set an example which other countries, with far greater scientific resources, might do well to follow.

Medical Research and its Benefit to Humanity

In his Stephen Paget Memorial Lecture, "Humanity's Rising Debt to Medical Research", given before the Research Defence Society on November 16, Sir Henry Dale referred to the convincing evidence of

the success of inoculation against diphtheria, which has become available since he lectured to the Society in 1931. Systematic inoculation began in Hamilton, Ontario, in 1925, and the death-rate from diphtheria fell so steeply that after 1930 there were no more deaths and after 1933 no more cases. In Great Britain a full-scale preventive inoculation campaign was not inaugurated by the Ministry of Health until 1940 and was not fully under way until 1942. In 1940 there were still in England more than 45,000 cases of diphtheria, and more than 2,400 of these were fatal. As inoculation became effective, in spite of a counter-campaign, the numbers fell steeply and steadily until in 1954 there were only 173 cases; of the nine deaths, six were in children less than fifteen years old, and all in the minority who had not been inoculated. The value of preventive inoculation against tetanus is a more recent discovery, but there were only seven cases among the sixteen thousand wounded in the British Expeditionary Force in fighting its rearguard action to Dunkirk over soil known to be highly dangerous as a source of tetanus infection; these seven cases were all in the 10 per cent minority who had been persuaded to refuse protective inoculation.

Sir Henry also pointed out that the discovery of successful methods for immunizing dogs against distemper and the crippling condition known as 'hard pad' had, too, met a persistent campaign to induce owners to refuse this protection for their dogs. Sir Henry outlined some of the outstanding medical discoveries which had resulted from the experimental method during the past twenty-four years, such as mepacrine, the sulphonamides and penicillin, and the new types of anæsthetics; the use of some of these, such as curare, is still exposed to a cruel, if ineffective, campaign of denunciation and misrepresentation. The Research Defence Society, he said, needs and deserves all the support it can get in combating this attitude of blind obstruction.

Linen Research Association: Report for 1955

THE report of the Council of the Linen Research Association for the year ended September 30, 1955 (pp. 20; from the Association, Lambeg, Belfast; 1955), refers to the support forthcoming from all sections of the industry—this in spite of the difficulties of the industry, which has not recovered from the setback of 1952. A special committee has been appointed to put before the Industrial Grants Committee of the Department of Scientific and Industrial Research a statement of the Association's policy and programme for the next five years and of its financial needs, and the Department has agreed to continue the present terms of grant for the first year of the new quinquennium, while raising the contribution needed to earn the maximum grant from £32,000 to £40,000 for the last four years of the quinquennium and the maximum grant itself from £22,000 to £25,000. The Association has experienced increasing difficulty in recruiting new staff, and in its spinning research has given priority to a new servo-drafting control mechanism, which should improve the regularity of dry spun yarns and the dry spinning of flax to finer counts, and to a modified ring system for wet-spinning. A pneumatic tension gauge has been developed for measuring tensions on winding machines and dry-spinning frames, and means have been devised for restricting the size of the yarn balloon when warping linen yarns at high speed. Attention has been given to improved methods of applying vat dyes to linen fabrics and to the application of resins and other polymers to linen fabrics.

In connexion with the difficulties of the linen industry, it may be noted that, replying in an adjournment debate in the House of Commons on January 31, the Parliamentary Secretary to the Board of Trade justified the Government's decision to close the flax processing mills operating in Great Britain. He said that, unless considerable sums are spent on plant and new machinery, many years of operation and research will be required to do more than touch the fringe of the problem, and the Government does not consider that continued expenditure of £500,000 a year from public funds to maintain a small scheme covering 16,000 acres of land is justified.

Capper Pass Awards for Papers on Metallurgy

THE following Capper Pass Awards have been made by a joint committee representing the Institution of Mining and Metallurgy and the Institute of Metals for papers published during 1955 in the *Transactions* of the Institution and the *Journal* of the Institute: £100 to Dr. Maurice Cook, C. L. M. Cowley and E. R. Broadfield (use of refractories in low-frequency induction furnaces for melting copper alloys); £100 to P. M. J. Gray (extraction of uranium from a pyritic ore by acid pressure leaching); £50 to W. T. Edmunds and R. C. Lloyd (production of light-alloy drop forgings, their heat treatment, inspection and testing). The Awards are made from a fund given by Capper Pass and Son, Ltd., for the encouragement of scientific and technical papers dealing with processes and plant used in extraction metallurgy and on the subject of assaying, and also papers and processes used in all branches of the non-ferrous metal industry.

City and Guilds of London Institute: Fellowships

THE fellowship of the City and Guilds of London Institute has been conferred upon the following past students of the City and Guilds College or of Finsbury Technical College in recognition of their distinguished contributions to industry and the engineering profession: Dr. R. T. Colgate, chief technical works manager and chief chemist, Huntley and Palmers, Ltd., Reading; E. W. Moss, senior partner of Raworth, Moss and Cook, chartered patent agents; J. F. Pain, director of Dorman Long (Bridge and Engineering), Ltd.; B. G. Robbins, secretary of the Institution of Mechanical Engineers; and Dr. F. H. Rolt, formerly superintendent of the Metrology Division of the National Physical Laboratory, Teddington.

Psycho-Analysis and Contemporary Thought

THE British Psycho-Analytical Society is arranging a series of six evening lectures commemorating the centenary of the birth of Sigmund Freud; they will be given in the Friends House, Euston Road, London, N.W.1, under the general title of "Psycho-Analysis and Contemporary Thought". The dates, lecturers and subjects are as follows: April 13, Marion Milner (psycho-analysis and art); April 17, Donald W. Winnicott (psycho-analysis and the sense of guilt); April 24, Dr. Roger Money-Kyrle (psycho-analysis and philosophy); April 27, Dr. Elliott Jaques (psycho-analysis and social problems in industry); May 1, Dr. John Bowlby (psycho-analysis and child care); May 8, Dr. Ilse Hellman (psycho-analysis and the teacher). Tickets (4*s*. each lecture or 1 guinea

the series) and further information can be obtained from the Administrative Secretary, British Psycho-Analytical Society, 63 New Cavendish Street, London, W.1.

Advanced Courses in Technology

A most useful booklet for all in the London area who are interested in advanced technological studies has been prepared by the London and Home Counties Regional Advisory Council for Higher Technological Education. The booklet describes all the courses which are available and which are not announced in college calendars or prospectuses. They are, as a rule, part-time (usually evening) courses; but full-time courses which are specially arranged and are not of longer than three months duration are also included. The courses range from silicone polymer technology to the organization of civil engineering contracts and from advanced archive administration to the industrial applications of servo-mechanisms. The booklet is clearly indexed and gives particulars of the venues of courses, the lecturers, and the approximate fees. Copies can be obtained from the Secretary, Tavistock House South, Tavistock Square, London, W.C.1.

The Night Sky in March

New moon occurs on March 12d. 13h. 36m., U.T., and full moon on March 26d. 13h. 11m. The following conjunctions with the Moon take place: March 3d. 15h., Saturn 3° N.; March 11d. 0h., Mercury 7° S.; March 16d. 04h., Venus 1° S.; March 23d. 15h., Jupiter 6° N.; March 30d. 23h., Saturn 3° N. Mercury is too close to the Sun during the month for observation. Venus sets at 21h. 30m., 22h. 15m. and 23h. on March 1, 15 and 31, respectively, its stellar magnitude varying between −3·6 and −3·9 and the visible portion of its illuminated disk decreasing from 0·701 to 0·575; during the month its distance from the Earth decreases from 96 to 75 million miles. Mars rises at 3h. 50m., 3h. 25m. and 3h. on March 1, 15 and 31, respectively, and lies rather low in the constellation Sagittarius, in which it has an eastward movement and is a little south of α Sagittarii on March 23; its stellar magnitude varies between 1·2 and 0·8, and its distance from the Earth between 146 and 122 million miles during the month. Jupiter is visible throughout the night, setting at 6h. 25m., 5h. 30m. and 4h. 25m. at the beginning, middle and end of the month, respectively, and has a westward movement in Leo; its stellar magnitude varies between −2·0 and −1·9, the small decrease in brightness being due to its distance from the Earth increasing from 410 to 435 million miles. Saturn rises at 1h. 10m., 0h. 10m. and 23h. 10m. on March 1, 15 and 31, respectively, and lies rather low for good observation in Scorpius, a little north of β Scorpii; its brightness increases by 0·2 mag. owing to its distance from the Earth decreasing from 909 to 867 million miles during the month. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: March 18d. 19h. 36·1m., ι Tau. (*D*); March 22d. 23h. 45·9m., κ Cnc. (*D*), *D* referring to disappearance. The Sun enters the first point of Aries on March 20d. 15h. 21m.

Announcements

Sir Edward Appleton, principal and vice-chancellor of the University of Edinburgh, will deliver the Reith Lectures for 1956. The lectures, "Science and the Nation", will be broadcast on the B.B.C. Home Service in the autumn.

The Countess of Albemarle and the Right Hon. Lord Justice Morris have been appointed additional members of the University Grants Committee on matters relating to academic salaries only.

Prof. J. Piveteau, professor of palæontology in the University of Paris, has been elected a member of the Geology Section of the Paris Academy of Sciences in succession to the late Prof. A. Michel-Lévy.

The Ninth International Botanical Congress will be held in Montreal during the summer of 1959. Preparations for the Congress have been initiated, but the exact date and officers of the Congress will be announced later. For the present all communications should be addressed to the Secretary of the Executive, Dr. A. J. Skolko, Botany and Plant Pathology Division, Science Service Building, Carling Avenue, Ottawa, Ontario.

A meeting of the Malacological Society of London will be held on March 14 at 6 p.m. in the rooms of the Linnean Society, Burlington House, London, W.1, when "Pelagic Mollusca: Swimmers and Drifters" will be considered. Four papers will be read, and then the meeting will be thrown open for discussion. Further information can be obtained from the honorary secretary of the Society, G. I. Crawford, 18 East Drive, Carshalton, Surrey.

A short course on the elements of radiological protection (that is, personal safeguards against radiation) will be held at the Isotope School, Atomic Energy Research Establishment, Harwell, during April 9–13. The course will consist of lectures and practical work and is primarily intended for industrial users of radioactive isotopes. Application forms and further details can be obtained from the Isotope School and, as the number of places is limited, these should be returned before March 9.

The Industrial Committee of the Scientific Film Association is organizing a course on "First Steps in Industrial Film Making", to be held during March 5–8 at "Wansfell", Theydon Bois, Essex, a residential college of the Essex Local Education Authority. The course is not for those engaged professionally in the making of films but rather for those in industry who may have occasion to make a film (16 mm. silent or sound) in such fields as work study, the recording of processes or installations, or the simplest forms of illustration for instructional purposes. The course is residential, and the fee is 8 guineas. Further information can be obtained from the General Secretary, Scientific Film Association, 164 Shaftesbury Avenue, London, W.C.2.

The Ministry of Agriculture, Fisheries and Food is offering the following scholarships for rural workers or the children of rural workers, of seventeen years of age or more: twenty senior scholarships, tenable at universities or colleges, for a degree or diploma in an agricultural subject or veterinary science; thirty junior scholarships and six extensions for existing holders, tenable at farm institutes, for one-year courses. Selection is by interview only. Further information and application forms (to be completed by February 29) can be obtained from the Secretary, Ministry of Agriculture, Fisheries and Food (Room 290), Great Westminster House, Horseferry Road, London, S.W.1, or from education offices of County Councils.

COLONIAL RESEARCH IN THE BRITISH COMMONWEALTH

THE reports for 1954–55 of the Colonial Research Council and of the eight specialist advisory bodies and the Director of the Anti-Locust Research Centre are contained in a substantial publication of more than three hundred pages entitled "Colonial Research 1954–55"*. In addition, there are some notes on research matters not covered by the reports of the specialist advisory bodies, and appended is a list of schemes approved for research grants under the Colonial Development and Welfare Acts, April 1, 1954–March 31, 1955. At the end of each of the reports are lists of publications; and, with the membership of the various Councils or Committees and their terms of reference, the publication as a whole gives an impressive picture not merely of the magnitude and range of the effort devoted to research in Colonial problems by Great Britain but equally of the extent to which that effort is interlocked with the research organization generally in Britain whether in the universities or in government establishments. No document better calculated to refute the idea that there is any inherent reproach in the word 'Colonial' could easily be conceived.

The report of the Colonial Research Council points out that with the coming into force of the Colonial Development and Welfare Act, 1955, the provision for 1955–60 calls for an average annual research expenditure of £1,600,000 as against £1,173,381 during the year ended March 31, 1955, and an average of £1,240,000 over the past four years. Expenditure in the several fields of research is at different stages of development, necessitating continuous review of the financial situation, and the Colonial Research Council held the first of such reviews in April 1955 to consider the allocation of the available funds among the various fields of research. The fifty-two new schemes and forty-eight supplementary schemes made during the year, involving grants totalling £533,548, brought the net commitment chargeable against Colonial Development and Welfare Funds since 1940 to £12·5 million. Of the gross allocation of £13·5 million, 32·5 per cent has been for agricultural, animal health and forestry schemes, 15 per cent for medical research, 11·8 per cent for fisheries research, 9·7 per cent for tsetse and trypanosomiasis research, 9 per cent for social science and economic research, 7·9 per cent for insecticides research, 5 per cent for research sponsored by the Colonial Products Research Council, 3·6 per cent for anti-locust research and 5·5 per cent for miscellaneous schemes, including building and road research. About 39 per cent has been for schemes to benefit the East African Territories, 18 per cent for the West African group, 10 per cent for the South-East Asian Territories and Hong Kong, 8·8 per cent for the West Indian Colonies, British Guiana and British Honduras and 5·6 per cent for the Central African Territories.

Much the largest scheme approved during the year was £104,024 for the establishment and maintenance for an initial two years of the East African Scientific and Industrial Research Organization, but £50,000 was provided for the establishment and maintenance of the Colonial Road Research Section at the Road Research Laboratory, Harmondsworth, a supplementary £42,500 for the East African Medical Survey, and a supplementary £37,750 for the maintenance of the Anti-Locust Research Centre and its extra-mural activities. £31,483 was provided for the purchase of buildings at Kabete for the East African Veterinary Research Organization, £22,329 for the establishment of the Agricultural Research Station at Aden, £17,780 for silvicultural research in Nyasaland, and supplementary £16,683 for the Desert Locust Survey, £16,365 for maintenance of the Ebini Livestock Experimental Station, British Guiana, and £14,390 for maintenance of the Colonial Insecticides Research Unit, Porton.

The second annual report of the Colonial Products Council and Colonial Products Laboratory records that the Laboratory dealt with 829 inquiries during the year, and completed eighty-four investigations. Those of major interest included an examination of oil of *Leptospermum citratum*, which indicated a citral content of 40 per cent, and one of the limonene obtained as a by-product in the concentration of sweet orange oil, which showed the limonene to be of good commercial quality. Examination of the oleo-resin collected in an experimental tapping trial from *Pinus caribaea* Morelet in British Honduras was completed and also a second trial distillation on a larger scale. The effects of insect attack on groundnuts were further studied, and five species of illipe nuts that were examined for the agricultural authorities of Sarawak contained 64–66 per cent saturated acids, 33–35 per cent oleic acid and about 1 per cent of linoleic and more unsaturated acids.

Detailed studies were made of the composition of Barbados sugar-cane wax; and a further sample of sisal wax from Kenya gave wax polishes comparable with those obtained by using carnauba wax, but emulsion polishes hardened on standing. A study of the development of acidity in maize under insect attack has been started, and, in further work on the chromatographic resolution of the active principles of pyrethrum flowers, reversed-phase chromatography using silicone-impregnated kieselguhr columns gave a good separation of the pyrethrin I and pyrethrin II fractions. Further progress has been made in building up the reference collection of photo-micrographs of fibres from botanically authenticated plants, and a satisfactory fibre was obtained from experimental yarn produced in a bulk spinning trial on a sample of Nigerian anaphe silk, probably derived from *Epanaphe moloneyi*.

At the Colonial Microbiological Research Institute, Trinidad, a start has been made in following the microbiology of 'microfermatories', and the distribution of free sugars and glycosides in the cacao bean has been studied. Further work on the development of the antifungal antibiotic, comirin, now lies mostly outside the scope of the Institute, but the nature of the antibiotic effect against fungi and

* Colonial Office. Colonial Research, 1954–55. (Reports of the Colonial Research Council; Colonial Products Council; Colonial Social Science Research Council; Colonial Medical Research Committee; Committee for Colonial Agricultural, Animal Health and Forestry Research; Colonial Insecticides Committee; Colonial Economic Research Committee; Tsetse Fly and Trypanosomiasis Research Committee; Colonial Fisheries Advisory Committee; Director, Anti-Locust Research, and Research Matters not covered by the above Reports of the Specialist Advisory Bodies.) Pp. 316. (Cmd. 9626.) (London: H.M.S.O., 1955.) 9s. net.

yeast has been more closely investigated in an attempt to elucidate the point of attack of comirin on the fungus. The preliminary difficulties encountered at the newly established jute estate near New Amsterdam in British Guiana now seem to have been overcome, and retting dry ribbon no longer seems to be a problem, but the original difficulties point to the necessity for 'seasoning' tanks and using a 'starter'. The Sugar Technological Laboratory, Trinidad, has completed work in connexion with the modernization of the experimental sugar factory, and studies on the variation of cane-juice constituents with plant growth conditions have shown that in the greenhouse a refractory juice can be produced to order by simply controlling the water supply to the cane. Use of sodium fluoride in clarification has been examined critically, and a study undertaken of the thermal conductivity of sugar cane, while a detailed study is being made of the soft fatty fraction obtained as a by-product of wax manufacture.

Investigations into the production of fibreboard from secondary Colonial timbers continued at the Forest Products Research Laboratory, Princes Risborough, where experimental work on the processing conditions for hardboard from four Malayan timbers has been completed. At the University of Birmingham work continued on the synthesis of cellulose by the organisms *Acetobacter acetigenum* and *Acetobacter xylinium*, and on the characteristics of dextransucrase from *Leuconostoc arabinosaceus*, and the mechanism of the reaction between sugars and amino-acids was being investigated using model sugar–amino-acid systems; the anti-acetylcholine activity of several series of compounds, including antihistamine agents, has been determined, and it was observed that introduction of several halogen atoms in the molecules of three classes of antihistamines modified their anti-acetylcholine activity. At the Royal Technical College, Glasgow, the constitution of the triterpene alcohol, taraxerol, has been determined, and investigations into the nature and properties of the undesirable highly coloured constituents of mangrove tanning extracts continued at the University of Leeds. At the University of Nottingham the Colonial hardwood, rengas, has been shown to contain two pigments, the more abundant being probably 4 : 3′:4′-trihydroxybenzylidene-6-methoxycoumarone, with very small amounts of an isomer, and the quantitative aspect of the production of oligosaccharides from glucose and the purification of Floridean starch have been studied at the University College of North Wales, Bangor.

The eleventh annual report of the Colonial Social Science Research Council, to which are appended reports from the East African Institute of Social Research, the West African Institute of Social and Economic Research, the Institute of Social and Economic Research, University College of the West Indies, the Rhodes–Livingstone Institute, the Educational Research Institute for Fiji and Western Pacific Territories, and the Social Research Unit, University of Malaya, expresses the opinion that, while funds available for research by individual scholars will be severely limited, the new allocation of £525,000 should suffice for a reasonable level of activity by the regional Institutes of Social and Economic Research, provided they can attract funds from other sources. Much time was devoted by the Council during the year to the question of making regional institutes ready for transfer as university institutes to the parent universities and university colleges at the end of their present Colonial Development and Welfare period, but the success of these plans depends largely on matters outside the Council's control. The Council for Technical Co-operation in Africa South of the Sahara has set up an Inter-African Committee for Social Sciences, and the first inter-African conference under the auspices of the Committee was arranged at Bukavu during August-September 1955.

The research section of the Department of Social Welfare in Singapore completed a socio-economic survey of family living conditions in Singapore City and also a survey of listening habits and tastes of Chinese households, while in Malaya the Department of Aborigines undertook some ethnological research, mainly to establish the geographical distribution and to collate material on the political and social organization of aboriginal tribes. Twenty-six volumes of the Ethnographic Survey of Africa had been published by the end of the year, and two further volumes were in the press. The first volume of the North Bantu Borderland Linguistic Survey was also ready for the press. A bibliographical survey of available material on labour productivity in British African Colonies is being made, and the preparation of a Ga-Adangme dictionary was started. A study of Iban agriculture, the last of the anthropological studies in Sarawak, is in the press. At the East African Institute of Social Research, work in Buganda was mainly in connexion with the study of change in patterns of authority and social stratification in Buganda and the North Nyanza district of Kenya. The West African Institute of Social and Economic Research expects in the near future, over and above the research programme for its permanent staff, to assist a five-year programme for a cultural history of Benin and a survey of the groundnut- and cotton-producing areas of Northern Nigeria. Research in progress at the Rhodes–Livingstone Institute covers both urban and rural studies, including a social survey of Livingstone, a study of family economics and nutrition in the copper belt of Northern Rhodesia and field work among the Lungu. Studies by the three Fellows comprising the Social Research Unit, University of Malaya, have included an analysis of land usages and transfers at Parit Sulong, with particular reference to the alleged encroachment of Chinese, and an examination of inter-racial attitudes, their bases and rationale, the relation of Chinese farmers at Sungei Derhaka, in Province Wellesley, to the Malays on whose land they have settled and among whom they work, and the social conditions of the inhabitants of a street in the 'Chinatown' area of Singapore.

Six small schemes, applicable to the tropics, two of which were for home-based work at the Universities of Liverpool and London, were added to the twenty-one established research schemes under the supervision of the Colonial Medical Research Committee at the beginning of the year. The Committee's tenth annual report records five new appointments to overseas research units, two of which were to newly created posts, and states that the Colonial medical research studentships are increasingly filling their purpose. Tribute is also paid to the value of the work of the Sub-Committee on the Sickle-Cell Trait in fostering research in this field, while the Helminthiasis Sub-Committee has recommended that a group of young zoologists should be given basic training under recognized specialists in the varied

aspects of malacology, in particular the systematics of the snail, at appropriate laboratories at Glasgow, Liverpool, Reading, London and perhaps in Europe or the United States, and also afforded opportunities to study the infestation overseas. The East African Standing Advisory Committee for Medical Research stresses the need for statistical and demographic studies and for co-operation among agricultural, veterinary and medical workers concerned with nutrition. The East African Council for Medical Research held its first meeting in January 1955, and the West African Council for Medical Research met for the first time in March 1955 at Lagos.

Studies on loiasis in the Cameroons and Nigeria have included the continued study of the population of flies and its infection-rate at Kumba and Sapele; the biting-cycle of *C. silacea* at all levels of the forest up to and above the canopy, using an improved technique for scaling the giant trees in the tropical rain forest, and trial of the use of 'Hetrazan' in controlling the transmission of loiasis. It seems likely that use of 'Banocide' for this purpose may be of practical value in developed areas where the population can be adequately covered and monkeys are not a potential reservoir. Infection of captive monkeys (*Mandrillus leucophaeus*) has now been achieved. In East Africa the Filariasis Research Unit has now been merged with the Medical Survey. In Malaya, blood surveys made by the Filariasis Research Unit at Kuantan, along the Pahang River, revealed a high incidence (60 per cent microfilaria-rate in those aged 4–5 years) in young children, and the results suggest that a very high rate of transmission occurs indoors and that most infections are thus acquired. Experiments to find a practicable treatment by 'Hetrazan' continued on carriers of *W. malayi*, and trappings of mosquitoes with Mangoon (stable) traps confirmed that *Mansoniodes longipalpis* (*longipalpis* plus *bonneae*) is the major vector and that it will feed on many animals and is equally attracted to man or goat.

Investigations on guinea-worm at University College, Ibadan, indicate that *Thermocyclops nigerianus* Kiefer is the most widespread intermediate host in south-west Nigeria and is highly adapted to pond water. Laboratory and field studies on the transmission of vesical schistosomiasis continued in the Gambia and, with its further expansion during the year by a group of World Health Organization workers, the designation of the East African Malaria Unit has been changed to the East African Institute of Malaria and Vector-Borne Diseases, to accord with its increasing scope. Continued examination of 'Dieldrin' as a mosquito larvicide has shown it to be some ten times as lethal as DDT, and the granulated form is a valuable new preparation. The Malaria Control Pilot Project in Western Sokoto, Northern Nigeria, found a surprisingly rapid loss of potency of residual 'Dieldrin', DDT and BHC on the mud walls of human dwellings. In solid form 'Dieldrin' and 'Lindane' were the most effective toxicants against the larvæ of *Aedes aegypti* and *Culex fatigans*; in aqueous suspensions the order of efficiency was 'Dieldrin', 'Lindane', DDT. In Kenya, investigations were initiated on the metabolism of *Plasmodium knowlesi*; using the fluctuation in quantity of the adenosine phosphates as an indicator of the energy resources in the parasite–erythrocyte complex, it was found that the parasite draws upon the energy resources of the erythrocyte during its multiplication in the blood stream, and that the adenosine triphosphate and diphosphate contents vary inversely with the percentage of parasitized cells.

A detailed entomological survey to determine to what degree West African strains of *Aedes aegypti* are domestic species and therefore accessible to larvicidal control measures, and whether this species is the sole or even the most important local vector, has been commenced in and around Ilobi, a typical rain-forest belt village fifty miles from Lagos, while from the results of surveys of yellow-fever antibody in man and monkey made during the past ten years certain epidemiological patterns in south, south-west, eastern and northern Nigeria emerge.

In a study on the relation of the virus to its insect host, the East African Virus Research Institute at Entebbe has concentrated on the genetical and breeding aspect, to elucidate why only some mosquitoes are infectible; other studies at Entebbe concern the relation of virus to host tissues and the behaviour of Rift Valley fever in the mouse, while in collaboration with the Laboratoire Médicale de Stanleyville, Belgian Congo, a survey was made of yellow-fever immunity among forest pigmies. Tests of the Malayan strain of *Aedes aegypti* have shown that under laboratory conditions it is a most effective vector for the transmission of yellow-fever virus by bite. The Trinidad Regional Virus Laboratory, Port of Spain, has given full attention to yellow fever, following the isolation of yellow-fever virus from a patient from a forestal region of Trinidad; immunity surveys have also revealed that dengue is widespread throughout the island and that ilheus is widespread in the lowland high-rainfall–forest–cocoa area. In Malaya sera from six rural communities exposed to different predominant biting mosquitoes were being examined for antibodies to yellow fever and Japanese encephalitis, and a comprehensive clinical and laboratory study of acute febrile illnesses in and around Kuala Lumpur was undertaken to define their etiology and determine the part that arthropod-borne viruses might play in their causation. Study of Japanese encephalitis in Malaya was extended to a search for the natural mosquito vector, and at the Lister Institute of Preventive Medicine, Elstree, the identification of blood-meals of insects continued.

In Uganda the work on the body composition of malnourished African subjects before and after feeding with high-calorific diets of high protein content continued, and the water and protein contents of muscle obtained at autopsy and operation were investigated; studies of the hæmoglobin and serum protein of subjects living in the high (non-malarious) districts and in the lower (malarious) districts of Kigezi led to the tentative conclusion that the high values for gamma-globulin are in part due to malarial infection. Data on the potassium and sodium concentrates in the plasma of infants suffering from kwashiorkor show that plasma potassium values in children who do not suffer from severe diarrhœa are within control limits. At the Hot Climate Physiological Research Unit, Nigeria, a statistically designed investigation was made of certain variables in the standard Harvard pack test. A long series of trials began on the effect of air movement on performance, and also preliminary work on the distribution of body fluid and the composition of the body. An active programme of leprosy work at Singapore included a chemotherapeutic trial of isonicotinic hydrazide, and a study was made of the interrelationship of the Mantoux and Lepromin reactions in an attempt to evaluate the use of B.C.G. vaccine as a prophylactic

in leprosy, which indicated that leprosy attacks essentially the Mantoux-negative individuals and that infection with tuberculosis resulted in some resistance to leprosy. A new mass-treatment campaign has been started in Kneba against *Microfilaria bancrofti* infection using 'Hetrazan' in conjunction with an anti-histamine drug. The search for new antibiotic-producing organisms, particularly streptomyces, from Malayan soil continues, and further mosquito infectivity experiments have confirmed that, in patients carrying gametocytes of a proguanil-resistant strain of *P. falciparum*, anopheline mosquitoes can be infected from a person taking 0·4 gm. proguanil daily. Further observations in the Kitui kala-azar area indicate that an anthropophilic species, provisionally designated *Phlebotomus* (*Sergentomyia*) sp. nov. 2, is the most likely vector of the epidemic, and experiments in Fiji indicate that the most effective dosage of 'Hetrazan' for control of filariasis is one 50-mgm. tablet taken on one day per month for twelve months.

(*To be continued*)

FOURTH NATIONAL CLAY CONFERENCE IN THE UNITED STATES

THE Fourth National Clay Conference of the National Clay Minerals Committee, United States, was held in the Department of Mineral Industries of the Pennsylvania State University, University Park, Pennsylvania, and consisted of seven sessions during the three days October 11–13. Approximately fifty-four papers were presented. Participants came from all regions of the United States, as well as seven from overseas: Dr. G. F. Walker (Australia), Dr. W. Dekeyser (Belgium), Prof. U. Hofmann (Germany), Dr. J. L. White and Dr. D. M. C. MacEwan (Great Britain), Prof. T. Sudo (Japan), Prof. J. M. Albareda (Spain). Dr. Hénin (France) was prevented by illness from attending. E. W. Radoslovich (Australia), J. Kulbicki (France), J. Zussman (Great Britain) and H. Heystek (South Africa), who were on extended visits to the Pennsylvania State University, were also present.

With such a wealth of papers, it would be difficult to give a detailed report. The present account concentrates on certain topics which seemed to me to be of importance, and is bound to be coloured by personal interests. It may, however, not be entirely a matter of personal prejudice that the study of interstratified, or mixed-layer clay minerals, appeared to emerge as one of the important growing-points of this branch of science. Their existence was reported many years ago by Alexander and others[1], and, since then, gradually increasing numbers of studies of such minerals have been appearing. At the Pennsylvania meeting, a whole session was devoted to this topic. The use of Geiger-counter recording apparatus for X-ray diffraction allows very extensive surveys to be made in a relatively short time. C. E. Weaver reported on the examination of three thousand sedimentary rocks, his conclusion being that interstratified clays are among the commonest mineral types present in the clay fraction. Systems identified are randomly interstratified illite–montmorillonite, chlorite–vermiculite, illite–chlorite–montmorillonite, chlorite–kaolinite, and regularly interstratified chlorite–vermiculite. A vermiculite–illite system, weathering to a 'chloritic' system (alumina in interlayer positions), was reported from New Zealand soils by T. Tamura. Schmehl and Jackson directed attention to the presence in soil clays of amorphous 'relicts', not giving distinct diffraction maxima, even on heating. T. Sudo reported certain Japanese acid clays which are randomly mixed kaolinite–montmorillonite; some of these minerals show almost no basal reflexions, a phenomenon which has not been satisfactorily explained. Vanadium silicates resembling clay minerals were described by J. C. Hathaway, who reported that they show mixed-layer expanding structures, mica–montmorillonite and chlorite–montmorillonite.

The name 'corrensite' has been proposed[2] for (apparently) a regular 1 : 1 montmorillonite–chlorite, and two occurrences of similar material were described at this meeting by J. W. Early and I. H. Milne. Vermiculite–chlorite systems from soil and shales were described by H. Heystek. D. M. C. MacEwan reported a Fourier-transform investigation of a mica–montmorillonite interstratified system in a Silurian clay from Worcestershire, the system being strikingly similar to the 'Kinnekulle II' clay from Sweden[3]. E. W. Tooker found mixed-layer illite–montmorillonites as stages in the series biotite–illite–montmorillonite (in an extensive paper on altered wall-rocks in the Pre-Cambrian of Colorado).

R. Roy, with his collaborators, has continued his important studies at the Pennsylvania State University on clay synthesis and equilibria, and he reported (with D. M. Roy) on hydrogen–deuterium exchange and the assignment of infra-red frequencies in clays (a caution against a too light-hearted assignment of absorption maxima to certain atomic groupings), and also on thermal transformations in dickite—namely, the formation of kaolinite by hydrothermal treatment of 'metadickite' and 'meta-metahalloysite', these substances being, of course, the analogues of 'metakaolin'. With F. A. Mumpton he has investigated the relation of ionic substitution to hydrothermal stability of montmorillonoids. Saponites are the most stable; the addition of polarizable ions (Zn^{2+}, Ni^{2+}) decreases the stability, as does the substitution of Ga^{3+} for Al^{3+} in beidellite. The interlayer ions also affect stability. Mumpton and Roy have further succeeded in synthesizing both regularly and randomly interstratified minerals.

G. W. Brindley and his collaborators have been continuing detailed structural work on clays. At the meeting, Newnham and Brindley reported on the structure of dickite, a two-dimensional Fourier investigation, which shows the octahedral layer of this mineral to have distortions of the same general type as in gibbsite (the first study of this sort on a dioctahedral mineral of the clay group); and on allevardite, confirming in general the results of Caillère *et al.*[4]. Brindley and Radoslovich have commenced a study of the hydrothermal alteration of single crystals of felspars. In Dr. Hénin's absence, Prof. Brindley also read his paper on low-temperature synthesis of clay minerals.

Other structural studies were reported by J. Zussman and G. F. Walker. Zussman proposes to divide the serpentine minerals into ortho- and clino-chrysotile, antigorite, and a third variety with orthogonal packing. (Whittaker, reporting on these minerals in November to the Mineralogical Society in London, proposed the name 'lizardite' for this

variety.) Walker has investigated in detail, using two-dimensional Fourier syntheses, the dehydration mechanism in vermiculite, and his paper may well form the foundation for much future thought on clay–water relationships, replacing the earlier ideas of Hendricks and Jefferson[5]. He recognizes a two-layer stage for the interlamellar water, with octahedral co-ordination around the exchange cations; then a less hydrous stage where the cations migrate to the mineral surface, followed by a one-layer stage; and finally, as more water is removed, the 'collapsed' form without interlamellar water occurs in interstratification with the previous stage.

Walker's paper was read during a symposium on "Clay–Water Relationships", in which H. van Olphen presented experimental evidence for the magnitude of the linking force in pure clay gels (10^{-4} dynes), and the height of the energy barrier for thixotropic gelling in 0·03 *N* sodium chloride solution (7 *kT*). In the same session, D. T. Oakes and E. J. Burcik described a method for electro-osmotic charge determination in concentrated suspensions; W. H. Wood, W. T. Granquist and I. M. Krieger described viscosity measurements on very dilute suspensions; W. C. Ormsby, R. M. Witucki and W. A. Weyl reported investigations on the effect of wetting agents on deformation of kaolinite suspensions; and U. Hofmann gave experimental evidence for a relation between surface charge of montmorillonite minerals (determined by chemical analysis) and swelling properties. C. W. Marshall, who was unable to be present, sent a paper on thermodynamic, quasi-thermodynamic and non-thermodynamic methods of investigating the electrochemistry of clays.

Another symposium was devoted to "Thermal Transformations in Clay Minerals". R. A. Rowland, E. J. Weiss and W. F. Bradley reported on the study of mono-ionic montmorillonites (Na, K, Li, NH_4, H, Ca, Mg, Mn), using the 'oscillating-heating' method, which consists in continuously scanning a small diffraction region, while heating the sample. The resulting diagrams illustrate very prettily the onset and progress of reactions. J. L. White described work on the effects of molten salts on layer-lattice silicates, the most striking result being the removal of potassium from (silt- and clay-grade) mica by molten lithium nitrate, giving a montmorillonite-like product. Other papers were on the dehydroxylation of illite (B. W. Nelson), and comparison of natural and synthetic montmorillonites (L. B. Sand and M. S. Crowley).

Advances in the technique of identification of minerals were referred to by E. B. Kinter and S. Diamond, and I. H. Milne and C. M. Wardshaw (preparation of samples for an X-ray diffractometer); and by A. Auskern and R. W. Grimshaw (infra-red spectrography). Aspects of industrial interest included paper-coating by kaolinite (H. H. Murray and S. C. Lyons); green compression strengths of bentonites (W. F. Bradley); and colloidal properties of silica and silicones (E. A. Hauser).

There was no symposium on weathering and alteration of minerals, but several papers were concerned with related questions. In Illinois (H. H. Murray and R. K. Leininger), and in Wisconsin (L. D. Whittig and M. L. Jackson), illite and chlorite have been found to alter to montmorillonoid (montmorin), or vermiculite. B. N. Rolfe described surficial sediments from Lake Mead (Hoover Dam area). B. Osthaus has studied the acid dissolution of montmorillonite and nontronite, and is able to distinguish two first-order reactions in the removal of iron and aluminium (octahedral and tetrahedral co-ordination ?). G. T. Kerr, R. H. Zimmerman and F. H. Wells have found two stages in the degradation of acid hectorite, with the release first of magnesium, and then of silicon dioxide. Anion exchange was discussed by S. J. Buckwold.

The entire series of meetings gave an impressive picture of clay mineral researches in the United States at the present time. It is noteworthy that some fine pieces of research have been done by industrial laboratories, especially those of oil companies. Most of the foreign visitors seemed to find the programme over-full, and would have preferred more time. This conference represented, of course, a year's research in the field. As compared with the diversity of effort in Europe (two meetings a year in Great Britain, France and Sweden; and others in Germany, Belgium, etc.) it showed the great advantages of organization on a continental scale, enabling all the workers on the subject to get together for an intensive discussion. The result was very inspiring. The complete proceedings of the conference will appear in book form, and are at present being edited by Miss Ada Swineford, of the Kansas Geological Survey. Like the second and third conferences, they will be published by the National Research Council, Washington, D.C., as will, so it is intended, the proceedings of subsequent conferences. The proceedings of the first (Bull. 169, Calif. Dept. of Mines, 1955) and second conferences have already appeared and form attractive and valuable records of progress in this field.

D. M. C. MacEwan

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THE METAPHYSICS OF SCIENCE

IN the Riddell Memorial Lectures* Prof. R. O. Kapp discusses a question which is, he says, of even greater importance for science than for theology, namely, "whether non-material influences have a real existence or not" (p. 8). Kapp defends an affirmative answer to this question, a doctrine that he calls "dualism", as against the negative thesis which he describes as "monism". This nomenclature is, I think, misleading, because various theorists such as Hegel have advocated a non-material, that is, spiritual, monism. Kapp supposes not only that the two metaphysical theories of dualism and monism are answers to a genuine problem, roughly 'What are the ultimate and irreducible constituents of reality ?', but also that they are the only two possible answers to the problem. These are, of course, very large assumptions indeed, and it is regrettable that Kapp fails not only to defend them but even to state them. He gives no grounds for presenting us with what, to my mind, are equally erroneous doctrines, nor for his assumption that one must vote for one rather than the other.

Kapp regards his problem as raising an empirical issue, namely, whether or not a certain sort of entity exists. The dualism that he defends is a causal

* "Facts and Faith". By Reginald O. Kapp. Riddell Memorial Lectures. University of Durham. Pp. 63. (Oxford University Press, 1955.) 5s.

hypothesis to account for the existence of 'order' in the universe. In this sense, which we shall see is a somewhat special one, order is explicable only if there exists a non-material cause or causes; of these we are offered a generous selection: "God, the soul, entelechy, élan vitale". The generic name given to these is "diathetes". At various places they are described as "things" (p. 13), "active realities" (p. 12) and "influences" (p. 8), but it seems clear that Kapp thinks of them as entities of a kind, as he is perplexed by the problem "That diathetes, be they called God, life, mind or the soul can be nowhere and yet do things is a most puzzling concept" (p. 53). We are not told whether these "diathetes" are fundamentally one, or whether they are separate; if the latter, then criteria should be given which would enable us to decide how many diathetes there are.

The argument that is advanced for the existence of diathetes is of the form of a causal hypothesis; they are said to be necessary to account for the existence of 'order' in the physical world. (It is not clear whether Kapp would regard as admissible any more direct attempt to establish their existence.) Only a certain class of physical events is the result of the causal activity of diathetes, those which occur in "living substance"; this notion is contrasted with that of the "rough untouched world of lifeless things", a phrase which recurs with hypnotic regularity. "A diathete can exercise direct control over any living substance and either only indirect control or none over all lifeless substance" (p. 17). A diathete is thus very like the driver of a motor-car—indeed this simile is explicitly used on p. 21. The crux of Kapp's argument is therefore the distinction between random and ordered events; only in living substance, he maintains, is order to be found, which is the result of 'diathetic' activity, while no such hypothesis is necessary in order to understand the processes of inanimate Nature, for these are all random.

What exactly is to be understood by the phrase 'the natural order' is, of course, a problem of the greatest importance for both philosophy and the natural sciences. Kapp recognizes the profundity of this somewhat neglected question; but his own treatment of it, so far as I can understand, is vitiated by a serious confusion. Kapp uses the words "order" and "random" as antitheses, but not always to point the same contrast. Sometimes "random" is used to mean simply "contingent"; for example, he describes the world studied by physics as "one in which anything may happen that is logically possible" (p. 36). From this quite true observation Kapp concludes in most misleading language that such a world is a 'random' one. The bounds of logical possibility are very wide, and include many concepts that are empirically *impossible*; as Russell has pointed out, there is no *logical* absurdity in the idea that the universe was created five minutes ago, complete with memories. Thus from the contingency of all factual propositions it is incorrect to conclude that there are no objective physical laws; logical and empirical necessity are concepts of quite different orders.

In denying that there is any objective order in physical nature, Kapp finds himself faced with the problem of explaining what the physical sciences are all about; if there are no laws in inanimate Nature, what are these sciences investigating? The discussion of this question is carried out with reference to Ohm's Law. Kapp argues, with some persuasiveness, that this principle should be regarded as a tautology, that is, as true by the definition of a resistance. With less plausibility this is alleged to hold true of all the laws of the natural sciences. In proposing a return to the conventionalism advocated by Poincaré some years ago, Kapp does not seem sufficiently aware of the objections that can be made against this view. Some of these are, briefly: (1) the fact that scientific laws can be represented as tautologies that are true by definition does not place them in any special category, for any proposition can be expressed as a tautology if sufficient latitude is allowed to our definitions; (2) if the principles of science are mere definitions, then it is not easy to understand how it is that scientific knowledge enables us to predict and control natural phenomena; (3) how, on such a theory, are we to explain, or even describe, the progress of the sciences? I do not deny that many, and perhaps all, scientific advances involve the re-definition of terms, but it by no means follows from this that the practice of science is to be understood as the invention of definitions.

A different use of the word 'random' can be found in those passages where Kapp contrasts it with the concept of 'ordered' as meaning the result of planning. He is much concerned to omit notions like those of 'consciousness' and 'purpose' because he believes that it is a fallacy to suppose that a diathete can operate only at a conscious level. Nevertheless, he talks as if he wishes to preserve the concept of teleology without having to face the difficulties raised by the idea of 'purpose'. Thus he compares "the extremely precise predictions that can be made in the biological sciences" (a rather paradoxical remark), with the 'predictions' about the product of the assembly line that an engineer can make from blueprints (p. 49). This somewhat special use of the word 'random' is again illustrated by Kapp's remarks about the stimuli that reach the brain. Of these he says: "They are not co-ordinated. They may arrive from anywhere. [I do not know what this means.] They are random events, unselected, most of them the result of pure chance. And yet the response of the brain to these stimuli is not random. Selection, discrimination, guidance, control do occur. Where, when, how?" (p. 20). Here 'random' clearly means 'not subject to guidance, control or selection'; and, of course, there is a perfectly good sense of the word 'chance' which means precisely this. A boy who breaks a window 'by chance' has not broken it intentionally; but this goes no way towards showing that the event in question was a chance or random event in the scientific sense, that is, inexplicable by the known laws of mechanics or psychology. The implicit teleology of Kapp's position may also be seen from the fact that he finds no incongruity in lumping together "houses, machines and living substance" (p. 36).

The concept of 'order', which is not only of great intrinsic importance but also vital to this particular argument, is unfortunately left as obscure as its antithesis 'random'. Kapp rightly believes that the notions of 'law' and 'order' are very closely connected, but he does not notice that there is here a profound ambiguity. The discussion of the conditions of order begins with a reference to human affairs. It is argued, quite correctly, that a necessary condition of order in this sphere is law "of the statute book kind". Certainly, laws of this character, such as those governing the behaviour of traffic, introduce order, in one sense of the word, into human activity. These laws "make for order", to use a phrase which often occurs in these lectures. Kapp now passes to the

question whether "the laws of physics are, like those in the statute books, of the kind that make for order" (p. 23). To this question, which I shall try to show is unintelligible, Kapp returns a negative answer, on the ground that, strictly speaking, there are no laws in Nature but only the definitions and conventions established by scientists. "The precision with which experiments are repeatable does not prove that it is in the nature of matter to behave in an orderly manner but only that it is in the nature of scientists to do so" (p. 45). And again: "The place of the laws of physics, we are led to conclude, is not in the world of physical reality but in the world of scientific methodology" (p. 62, Appendix). In passing, it might be observed that from this duplication of 'worlds' one can only conclude that so far as Kapp is concerned, Carnap's "Logical Syntax of Language" and Stebbing's "Philosophy and the Physicists" have been written in vain.

The problem of whether the laws of the natural sciences 'make for order' can arise, it seems to me, only as the result of a failure to recognize the ambiguity of the phrases "law" and "law and order". The traffic laws impose orderly conduct on motorists and others, and sometimes these "statute book laws", to use Kapp's somewhat unhappy phrase, may be difficult to enforce, as in Cyprus at the present time, in which case 'the rule of law' breaks down. But this does not mean that the phenomena in question become in any way unintelligible or unpredictable from the scientific standpoint. The reason for this is that 'statute book laws' are of a fundamentally different kind from those established by the sciences. The former are *prescriptive* rules which coerce human beings to behave in certain ways because sanctions are attached to them. Of an essentially similar kind are social rules and conventions. The laws of science (including, *pace* Kapp, those of biology) are entirely unlike these, for they are *descriptive* of the actual behaviour of the subject-matter in question, whether it be human, animal or material. Hence the laws of science do not 'make for' or impose order, for only prescriptive laws are capable of this; rather, they merely record the orderly relations which obtain between events. It is worth pointing out, incidentally, that in this distinction between prescriptive and descriptive laws, first clarified by Schlick, one can find the solution, or rather the resolution, of the problem of the freedom of the will.

In the seventeenth and eighteenth centuries this issue was somewhat bedevilled by certain theorists who represented the descriptive laws of Nature (often spelt with capitals) as prescriptive laws imposed by God on the Creation. This leads to the idea that the particles of a gas are 'governed' by Boyle's Law in the same kind of way that we are governed by the income tax laws. All this, of course, arises only from a failure to notice the different senses in which words like 'govern' and 'obey' are used. If Kapp had considered this, he could scarcely have employed language like: "Only on the reason why a particle of matter implicitly obeys the laws of physics may there be difference of opinion between a theologian and his atheistic opponent. The theologian might say it was because matter does not possess free will and cannot therefore sin against God's moral law. The atheist might object that the laws of physics were not ordained by God but by Nature and that a particle of matter obeys them implicitly because it is made in Nature's image and cannot do otherwise" (p. 28). The essential point is that the laws of Nature were not ordained by anybody, so that fortunately we do not have to speculate as to what can be meant by saying that something is 'made in Nature's image'. I conclude that Kapp is right in denying that scientific laws are prescriptive, but that his reasons for this are not convincing because he fails to see that there are perfectly good laws of another, that is, descriptive, kind. If this is admitted, then it appears that Kapp's notion of order, as it concerns the natural sciences, is misconceived, and so are his attempts to find its source in 'diathetes'.

C. K. GRANT

CENTENARY OF THE FORMER SCOTTISH METEOROLOGICAL SOCIETY

THE year 1855 saw the foundation of the Meteorological Office and the Scottish Meteorological Society, both as a result of the international conference on the meteorology of the sea held at Brussels in 1853, and the centenary of the Society's foundation was celebrated at a meeting of the Scottish centre of the Royal Meteorological Society held in Edinburgh on October 28. The principal address was delivered by Sir Ernest Wedderburn, honorary secretary of the Scottish Meteorological Society during 1909–20 and now vice-president for Scotland of the Royal Meteorological Society, and a summary of the address has been published in the November number of *Weather*.

Sir Ernest began by pointing out that it was Sir Henry James, then of the Scottish Ordnance Board, who proposed the formation of the Society as the best means of making available for public use the meteorological observations held by the Northern Lights. The first Council included Thomas Stevenson, designer of the Stevenson thermometer screen, and the first secretary, Dr. Stark, organized on a standard basis the work of seventy voluntary observers in Scotland and the subsequent publication of their observations by the Registrar-General. Unfortunately their preparation for publication soon had to be given up and was performed by the Astronomer-Royal for Scotland from 1858 until 1893, when it returned to the Society. In 1860, Alexander Buchan, later famous for his world climatological atlas and his work on the climate of Edinburgh, was appointed secretary, and he soon made his influence felt by arranging in 1864 for the publication of the Society's *Journal*, which flourished until 1920. He represented the Society at the Leipzig conference of 1872 and, with the Director of the Meteorological Office, the British Government at the Vienna conference of 1873 which did much to draw up an international code of practice in meteorological observing.

Interest in observations at high levels began early in the Society's life, and before 1870 three stations were in operation at above a thousand feet. The most famous single work of the Society, the making of observations on the summit of Ben Nevis, was first mooted in 1877; the observatory on the summit was opened on November 28, 1883, and hourly observations were begun and telegraphed to the Meteorological Office in London over a line laid down the mountain. In 1883, too, the Society set up a marine research station at Granton, at which Dr. R. H. Mill began his meteorological career.

Some government grant was received to assist the Society's work, but by the early years of this century the Society had been financially exhausted by the efforts to maintain the Ben Nevis observatory, which had, unhappily, to be closed in 1904. Negotiations with the Government resulted in 1912 in the granting of an annual sum of £350 from the Meteorological Office on condition the Society maintained an office in Edinburgh to provide for public service under the guidance of a committee, of which Sir Napier Shaw, director of the Office, was appointed chairman. Financial difficulties after the First World War led in 1920 to the complete taking over by the Meteorological Office of the Society's office and its public responsibilities, and at the same time an official Meteorological Advisory Committee for Scotland was set up with the director of the Office as chairman and a membership of representatives of the Scottish universities, learned societies and government departments.

The purpose of the Society, to establish meteorological work in Scotland on a permanent and comprehensive basis, having been achieved, the Society amalgamated in 1921 with the Royal Meteorological Society, which since 1944 has had as one of its honorary officers a secretary, more recently a vice-president, for Scotland. The balance of the funds was used to found the Royal Meteorological Society's Buchan Prize for meteorological research. Meetings of the Royal Meteorological Society were held in Scotland in 1921 and 1954, and a flourishing Scottish Centre was formed in 1946. Some famous names in meteorology connected with the Scottish Meteorological Society have been mentioned. To them may perhaps be added that of C. K. M. Douglas, who joined the Society in 1916 and published his first paper, on weather observations from aircraft, in the *Journal* the same year.

INTERNATIONAL REVIEW OF EDUCATION

THE problems of educational theory and practice, of educational psychology and sociology, of education in home, school and society, have become, more than ever before, matters of international concern. National educational systems and national educational ideas can no longer safely be developed without contact with educational thought and action elsewhere in the world. The maintenance of cultural life has ceased to be something to be guided by ideals purely national in scope.

For these reasons a new educational journal designed to provide an international forum and to promote international exchange of information does not require extended justification. The *International Review of Education* has been launched on behalf of the Unesco Institute of Education, Hamburg, and edited by Karl W. Bigelow of New York, Roger Gal of Paris, M. J. Langeveld of Utrecht, Walther Merck of Hamburg and Friedrich Schneider of Munich. Editorial consultants have been appointed in various countries throughout the world and include such well-known names as Prof. C. H. Dobinson, Prof. M. U. C. Jeffreys and Prof. F. J. Schonell.

One aim of the new journal will be to inform readers as to educational theory and practice in various countries. Another—and perhaps the more important—will be to explore the extent to which such ideas and activities have elements of validity that transcend national boundaries. Such exploration will, of course, require continuing discussion and debate.

In pursuance of its aims the *Review* hopes to develop an ever-strengthening chain of contacts with educational research and training centres throughout the world. Systematic attention will also be paid to international educational conferences and congresses, as well as those of more limited scope which possess special international interest. From the torrent of educational publications appearing everywhere it is the intention to select those of outstanding extra-national significance for critical examination.

The first four numbers of the journal have now appeared, and each contains articles in English, French and German; articles in one of these languages contain useful summaries in the other two. Besides articles by leading English educationists, the first volume of the journal contains a valuable account of the reforms in the French educational system since the War; a bird's-eye view of education in India; a description of educational reform and its problems in post-war Japan; two articles of different points of view on nationalism and internationalism; a survey of political education in France, Great Britain, Germany and the United States; a penetrating inquiry into the state of American education and its relation to politics; a comparison between "le français élémentaire" and basic English which suggests the latter may be too basic; and an interesting account of the way vocational training in Germany has been humanized.

SOURCES OF ANIMAL BEHAVIOUR

IN his inaugural address, delivered on May 5, 1955, at University College, London, and recently published*, Prof. G. P. Wells has drawn forcible attention to the importance of spontaneous rhythms in animal behaviour. His analytical studies of the lugworm *Arenicola* over the past twenty years have shown how little the normal behaviour of this worm seems to depend on the reflexes of a passive animal and how much depends on inherent rhythmic activity. Burrowing, feeding, defæcation and respiration are controlled by 'physiological clocks'. There is rhythmic activity originating from the œsophagus, and this itself recurs in outbursts controlled by rhythms of a higher order.

In any species there are many patterns of these rhythms, and the animal may pass abruptly from one pattern to another. These patterns vary with the species; and the different patterns of rhythms are recognizably characteristic of each species, quite as much as are the anatomical characters by which they are distinguished systematically.

To illustrate the generality of rhythmic patterns, Prof. Wells shows that, just as in his *Arenicola*, much recent work on the behaviour of birds suggests that this is governed by a variety of spontaneous rhythms —that is, regular activity not directly related to environmental stimuli. Rhythmic outbursts of song, feeding and reproductive cycles of behaviour recall the spontaneous rhythms of the worms. It is true that bird behaviour differs from worm behaviour in

* The Sources of Animal Behaviour. (An Inaugural Lecture delivered at University College, London, 5 May, 1955.) By Prof. G. P. Wells. Pp. 20. (London: H. K. Lewis and Co., Ltd., 1955.) 2s. 6d.

its much greater complexity and in the much greater indirect influence of external stimuli upon the rhythms and their patterns. But the fact remains that much that is most characteristic of the behaviour of both worms and birds depends on highly individual patterns of rhythmic activity apparently of internal origin.

The address is stimulating and leads one to many questions. What are these 'clocks' that control rhythmic behaviour? When we consider rhythmic contractility, on one hand, and reproductive cycles, on the other, it is clear that the clocks work on very varied principles. The one common feature is the rhythmic activity of the system whatever its grade of organization. Possibly it is a general character that they are systems in relaxation oscillation. Living organisms are dynamic, and it does not follow that they will naturally tend towards a constant steady state. Indeed, in many cases such steadiness is only achieved by the evolution of elaborate controls—as the proprioceptive machinery of limbs. Systems in relaxation oscillation may arise at many different levels of organization. Once they are there, they may inevitably be built into the behaviour of the organism through the operation of natural selection.

C. F. A. PANTIN

USE OF LOGARITHMIC NOTATION IN SCIENCE AND ENGINEERING

By PROF. S. DEVONS, F.R.S.
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FOR the past ten or twelve years I have been using, and encouraging colleagues and students to adopt, a logarithmic system of notation, in place of the conventional arithmetical one, as the normal one in which to express physical magnitudes and relations. Suggestions that logarithmic scales and units be used more widely have been made by numerous writers, and such systems have obvious advantages. The experience gained in the use of a general system of this sort confirms that the advantages are substantial, perhaps more than is generally appreciated, and that they definitely outweigh its drawbacks and are sufficient to justify its more widespread use.

A large proportion of statements in physical science are in the form: the quantity X, as measured (calculated), is n times a specified unit. The number n is not normally integral or exact. It is not arrived at by counting but by computation from primary physical measurements (empirical quantities), and in this process of computation multiplication plays a dominant part. One can see that this is the case by inspecting a typical table in a compilation of physical data, such as fundamental constants[1], electrical resistivities of metals[2], wave-lengths of X-ray lines[3] or abundances of isotopes[4]. One will find, normally, that the numbers are spread roughly uniformly over a limited logarithmic scale: for example, about 30 per cent of the entries will have the first significant figure 1, whereas only 5 per cent will begin with 9. (Even when the primary quantities are not 'logarithmic', the quantities derived after a few multiplicative steps soon tend to be so.)

The fact that most, although not all, of the quantities used in physical expressions and calculations are of this 'logarithmic' sort suggests that the normal notation to be used in expressing them, and numerical relations between them, should also be logarithmic, with some convenient unit of relative magnitude. A very convenient unit that has long been used in several branches of physics and engineering to denote a ratio of powers is the decibel ($10^{1/10}$, or approximately a factor 1·2), and many proposals have been made to adopt it (either with the same or a new name) for wider use. For the quite general use proposed in this article, a simpler and more distinct name and notation is called for. I have used the term 'jot' for the unit, and I have found the notation $x = (\text{unit} \pm xyz.ab)$ jot, with the word 'jot' normally omitted, to be simple and unambiguous. It readily permits the simultaneous use of logarithmic and normal notation. Thus, for example, electron charge = (e.s.u. − 93·2), velocity of light = (cm./sec. + 104·8), to an implied accuracy of ± 0·05 jot (or about 1 per cent). No confusion arises in addition, subtraction, etc.; for example, (c.g.s. + 82·1) + (c.g.s. + 86·2). A notation such as this which emphasizes the unit has considerable pedagogic value. Some other advantages of the logarithmic notation are as follows.

Simplicity of calculation. Just as so many of the physical quantities one deals with are 'logarithmic', so, naturally, the arithmetical manipulations in which they are involved are predominantly multiplicative (including roots, powers, reciprocals). These manipulations become, obviously, greatly simplified and far less liable to error if one starts, works and finishes with the quantities expressed in logarithmic notation. Of course, addition and subtraction become more complicated, but since these operations normally involve quantities of the same order of magnitude, whereas multiplication often involves many orders of magnitude, it is advantageous to have the notation suited to the more frequent and important operation.

Economy of notation. As previously indicated, ordinary arithmetical notation does not use all the digits equally when dealing with usual physical magnitudes. Less digits are required, on the average, to indicate a specified accuracy on the logarithmic scale. This, coupled with the simpler notation, makes quantities expressed logarithmically easier to write, remember, and particularly to manipulate mentally. Compare, for example, $m = 1{\cdot}67 \times 10^{-24}$ gm. with m = (gm. − 237·8), which has three less digits, and all the digits are on a similar footing.

Another feature of the logarithmic system is the possibility of 'normalizing' the scale of measurement so that a high accuracy can be expressed with few digits. For example, the specific gravity of a liquid might be expressed as (unity + 0·2), with an accuracy of 1 per cent, whereas normally this accuracy would require three digits.

Simplification of units. An expression such as $a_0 = 5{\cdot}292 \times 10^{-9}$ centimetres (Bohr radius) is clearly both inconsistent and uneconomical in its notation. First, we have a mixture of logarithmic and linear notations: the digits themselves are

linear; whereas the decimal, exponent of 10, and the prefix centi- are all logarithmic, and all three doing the same job. With a consistent logarithmic notation such as the one proposed, multiplication even by large powers of ten does not result in clumsy expressions, so that the need for many units differing by powers of 10 is largely obviated.

For example, suppose we are making (mental) calculations to an accuracy of about 10 per cent, so that we work to the nearest jot, with mean individual error of 5 per cent. Then with four hundred three-digit numbers and ± signs we cover the range of magnitudes 10^{60} to 1, sufficient for most purposes. Moderately accurate calculations can be made in any system of units, and the task of memorizing physical data is made significantly easier. For example (to an accuracy of ½ jot), r_e (classical radius of electron) = (cm. − 126). Using c = (cm./sec. + 105) and year = (sec. + 75), we get r_e = (light-year − 306), which is scarcely more difficult to deal with than (metre − 146) or (angstrom − 46). With a notation that can express the size of the electron as conveniently in light years as in angstrom units, there is little need for a large multiplicity of units (and especially of length). The use of a single unit in all branches of physical science would not only simplify many calculations, but it would also bring out, most directly, the relative magnitudes of different physical quantities, related and otherwise.

Representation of errors. In logarithmic notation the sign and the number of digits before the decimal point indicates the magnitude; that after, the precision. Without further specification, no digits after the point indicate an average accuracy of ± 5 per cent, one digit ± 0·5 per cent, etc. For normal error distributions, the accuracy can be given directly and absolutely by additional figures (for example, superscripts) giving the size of error in units of last digit written. (The ± sign is redundant, and more than one figure is seldom required.) For example, c = (cm./sec. + $104{\cdot}77^{2}$) would indicate an accuracy of the quoted value of 0·02 jot or about ± 0·4 per cent.

The systematic use of logarithmic notation does involve transcription into this notation of quantities such as meter readings, some numerical constants, and data presented in conventional form. The most frequent of these is the last-mentioned, and this task would be avoided if the notation were generally used and accepted. The incorporation of non-dimensional constants presents no difficulties; for example, the expression 4π(e.s.u. − 82·5) is quite unambiguous and, moreover, displays the nature of the quantities involved very directly. Fortunately, π and powers of 2 can be expressed quite accurately in integral units (jots), and even '137' can be replaced by 21·37 to an accuracy of one or two parts in a thousand! Primary observations fall into two groups: some, such as micrometer or thermometer readings, involve counting and additive operations; others, such as most electrical instruments, do not, and there is much to be said for having the scales of these latter marked in both logarithmic and linear fashion.

To summarize: the use of logarithmic systems simplifies notation and calculation, eases the burden on memory and reduces the need for a multiplicity of units. Whenever I have had occasion to propound the merits of the system, I have generally found ready acceptance of the points made here, and this leads me to propose general use of some such system.

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SONIC SCATTERING LAYERS OF HETEROPODS

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DURING a nineteen-day oceanographic cruise in April 1955 in Bass Strait, southern Australia, the Fisheries Research Vessel *Derwent Hunter*, using a 14-kc./s. echo-sounder (Kelvin Hughes MS 24*E*), repeatedly detected sonic scattering layers over a large and well-defined area of continental shelf. The layers were diffuse and quite unlike fish traces, and varied greatly in density; they were virtually confined to the top 20 m. of the sea and were generally found in the upper 10 m., by both day and night.

Fig. 1 shows the track of the ship, distinguishing the long echo-sounded portion; the stations at which plankton was collected; and the sections of the track along which the layers were found, which were all east of 145° 15′ E. long. The longest section over an unbroken layer was about seventy miles.

Fig. 2 shows a portion of the echogram record of the densest of these layers, taken just before and during the occupation of one of the stations (No. 1 in Fig. 1), on a calm night.

Vertical bottom-to-surface hauls were made in duplicate with the "Discovery" *N*70 plankton net at each station on the continental shelf, and similar paired hauls from 500 m. to the surface were made at each station on the continental slope. Echo-sounding was done at twenty-seven stations, fourteen at which layers were detected and thirteen at which they were not, and was omitted at fourteen stations (mostly on the continental slope).

The plankton catches were checked to try to identify some organism which (*a*) was present at each station at which a scattering layer was found, and (*b*) was absent at each station at which no layer occurred. No organism completely satisfied these conditions, but three species met them closely: the cladoceran *Evadne nordmanni* Lovén, the lancelet *Paramphioxus bassanus* (Günther), and the heteropod mollusc *Firoloida desmaresti* Lesueur.

Evadne nordmanni was absent at one station where there was a scattering layer, and present at three stations, including one as far west as 143° 15′ E. long. (No. 4 in Fig. 1), where there was no layer. This species is most unlikely to have caused the echo-sounder traces because it is very small (about 0·5 mm. long) and was not very abundant at any

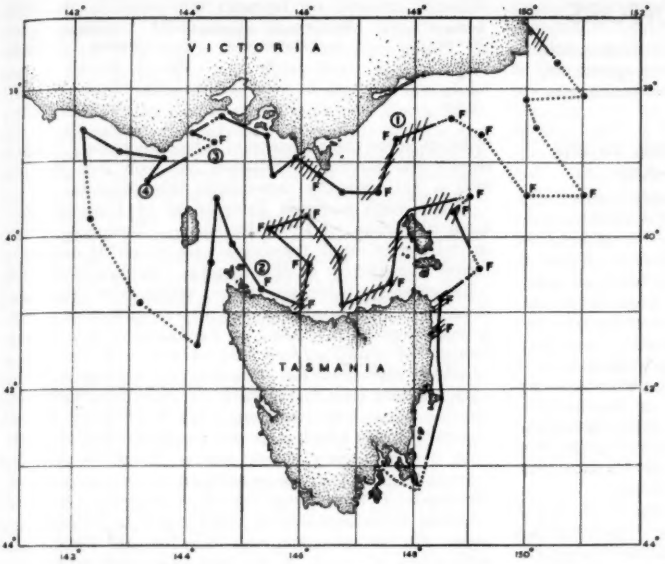

Fig. 1. Chart of the cruise showing the echosounded (——) and un-echosounded (· · · ·) portions of the track, and station positions (●). The occurrence of the scattering layer is indicated by hatching, and of *Firoloida* (in plankton catches) by the letter *F*. For further explanation see text

station. At the station to which Fig. 2 refers, for example, only about two hundred individuals were taken in two vertical hauls.

Paramphioxus bassanus was absent at four stations where there was a layer, including the station to which Fig. 2 refers, and present at three stations where there was no layer. The greatest density was observed at one of the three latter stations, and elsewhere the numbers did not exceed ninety-one for a pair of vertical hauls. The animals were only about 5 mm. long, and as lancelets are benthic forms it is most unlikely that the scattering layer consisted of this species.

Firoloida desmaresti was taken at eleven of the fourteen stations where there was a layer and at one of the thirteen stations at which there was no layer. The best catch, nineteen for a pair of vertical hauls, was made at the station to which Fig. 2 refers, where the scattering layer was densest. The average length of the specimens was about 40 mm., diameter 4 mm., and volume 0·4 ml.

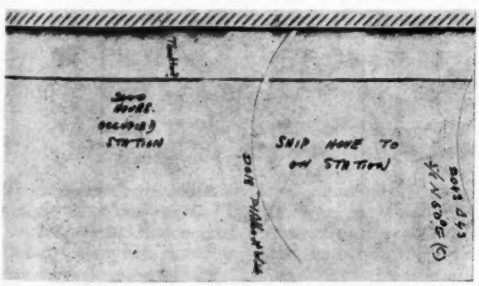

Fig. 2. Portion of echogram showing the appearance of a dense scattering layer before and during the occupation of a station (No. 1 in Fig. 1). Note time scale in minutes above. Depth of water 75 m., with layer confined to upper 20 m.

According to Tesch[1], *Firoloida desmaresti* is given to swarming, and the members of the family to which it belongs, the Pterotracheidae, are active and fast-swimming. This could explain why larger numbers were not captured and why the species was not taken at all at three stations at which a scattering layer was seen: the animals might have avoided the net. Fig. 2 shows some discontinuity of the layer beneath the ship while she was on the station, which could be due to disturbance of the animals by the raising and lowering of nets. A re-examination of the echograms at the three above-mentioned stations showed that the layer was faint or absent at the actual times the plankton nets were used, at two and possibly all three stations.

One specimen of *Firoloida* was taken in two hauls at one station at which the echo-sounder revealed no sign of a layer (No. 2 in Fig. 1); and here, just beyond the western boundary of the general area of the scattering layer, it may be assumed that the numbers were insufficient for the formation of a detectable layer. The same might have been true of another station still farther to the west (No. 3 in Fig. 1), where only one specimen was taken in two hauls, but there was no echo-sounding at this position.

Thus *Firoloida*, by virtue of its size, habits and distribution in relation to that of the scattering layer, is far more likely to have been the constituent of the layer than any other organism sampled by plankton nets. There remains the possibility that the layer consisted of some animal which avoided the nets on every occasion. Such an organism would probably be one of the smaller members of the nekton, such as a small fish or cephalopod. However, the nekton of this region is fairly well known from a study of the stomach contents of the omnivorous pelagic scombroid fish *Thyrsites atun* (Euphrasen), which I am studying, and only one nektonic species apart from *Thyrsites* itself has been found to occur in abundance in Bass Strait at the time of year in question. This is the anchovy, *Engraulis australis* (White), which gives echogram traces of a very different kind. *Thyrsites* itself has not yet been found to give any well-marked echogram trace, and its distribution at the time of year under discussion is generally coincident with that of the euphausian *Nyctiphanes australis* Sars, on which it preys; and *Nyctiphanes*, on the cruise of April 1955, was most abundant to the west of the region of the scattering layer.

The sonic scattering layer described may therefore be attributed to the swarming of the pterotracheid heteropod mollusc *Firoloida desmaresti* Lesueur. The swarming was probably for reproductive purposes, as many females had egg chains.

The work described was part of the research programme of the Division of Fisheries, C.S.I.R.O., Australia. Mr. W. Dall, of that Division, identified the plankton of the cruise. [Oct. 14

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Sensitivity of the Mouse Testis to the Mutagenic Action of X-Rays

In making estimates of the damage caused by exposure of human gonads to ionizing radiation, it is essential to take into consideration variations in sensitivity of the germ cells at different stages in their development. In *Drosophila*, this has been done by mating irradiated males to a succession of females and determining mutation-rates separately for successive broods[1]. It was found that spermatids, probably at the stage of transformation into spermatozoa, are the most sensitive stage; mature spermatozoa are one-third or one-fourth as sensitive as spermatids, and spermatocytes are intermediate. Spermatogonia are the least sensitive: a given dose of X-rays produces only one-third to one-half as many mutations in spermatogonia as in spermatozoa.

This last point is of particular significance for estimates of radiation damage in man. In a human population exposed to chronic irradiation, spermatogonia form the majority of treated cells, and it is their sensitivity which in the main determines the genetical effectiveness of the exposure. As extrapolation from *Drosophila* to man seems hazardous, it would be of the greatest value if the 'sensitivity pattern' of the testis could be established for a mammal, for example, the mouse. Unfortunately, the most important comparison—that between spermatozoa and spermatogonia—requires scoring of genetical effects which are not subject to germinal selection during and before meiosis, and this rules out the two most frequent effects in the mouse, namely, dominant lethals and translocations. These can, however, be used for comparing the sensitivity of post-meiotic stages. If the post-meiotic sensitivity pattern of the mouse testis should resemble that of the *Drosophila* testis, we may with some confidence extrapolate to pre-meiotic stages and predict that in mammals, as in *Drosophila*, spermatogonia will be less sensitive than spermatozoa.

Hertwig[2] and Russell *et al.*[3] compared the frequencies of dominant lethals in litters produced during the early and late part of the pre-sterile period; they found significantly higher frequencies in the late litters. This suggests that in the mouse, as in *Drosophila*, X-rays produce more genetical changes in spermatids than in mature spermatozoa. We have carried out a pilot experiment to test this conclusion for translocations.

Five wild-type males from crosses between inbred lines were exposed to X-ray doses varying from 400 to 600 r. Each male was given five females, and every morning females which had copulated during the night were replaced by new ones. All sons which had been conceived during the pre-sterile period were tested for fertility by mating to several (two to six) females which had had litters of seven or more young by untreated males. Sons of treated males which produced average litter sizes of less than nine were suspected of semi-sterility and were examined cytologically for translocations. Twenty separate chromosomal elements seen in at least five metaphase plates of the first meiotic division were taken as evidence for the absence of a translocation. The consistent presence of nineteen separate elements served as indication for the presence of a translocation. Table 1 shows the strong correlation between low fertility and a cytologically detectable translocation.

Table 1

Average litter size	No. of males examined cytologically	Translocation present	Translocation absent
0	2	2	0
6	18	18	0
6–6·8	8	2	6
7–8·9	3	0	3

Males with average litter sizes of nine or more were not examined cytologically. This may result in the loss of small translocations which do not cause lethal aneuploidy of the zygote. In fact, one male with average litter size nine, which was examined because it had produced two litters of seven, carried a translocation involving an exchange of minute segments, so that, in one out of six cells examined, nineteen chromosomal elements were present. This case was not included among the translocations, since similar small translocations may have been present in fertile males which were not examined cytologically. One of the highly sterile males carried a complex interchange which was scored as two translocations. No controls were used, for the occurrence of spontaneous translocations in mice must be exceedingly rare. No translocation was found in 248 *CBA* males which one of us (B. M. S.) had examined previously, and none has been reported in the literature.

Table 2. Numbers of Translocation Heterozygotes among F_1 Males

Litter number	Mouse 1	2	3	4	5	Trans.	Total animals	%
1	1/4	1/5	1/5	0/5		3	19	15·8
2		1/3			0/2	1	5	20·0
3	1/7	1/5	0/5	0/2		2	19	10·5
4	0/2	1/4	1/5	0/3	0/3	2	17	11·8
5			0/2	3/4	0/3	3	9	33·3
6	2/2	0/1	2/5	0/1	0/1	4	10	40·0
7	1/6	1/3	1/2		1/5	4	16	25·0
8		0/2	1/2		0/3	4 {1, 2, 1}	{7, 2, 7}	25·0
9					2/2			
>9			1/7					
	4/21	5/23	8/33	3/15	3/19	23	111	

In Table 2 the full results are presented. In the last column the overall translocation frequency has been calculated for each litter number, and these figures have been plotted in Fig. 1.

It will be seen that after the fourth litter translocation frequency rises to a higher level, which is more or less maintained to the end of the pre-sterile period. If the slight decrease in the last litters is more than an effect of chance variation, it may be assumed that the sperm used for these litters could be traced back to irradiated spermatocytes, in which

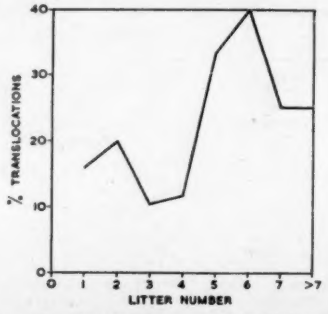

Fig. 1. Translocation frequency in successive litters

germinal selection has started to operate against translocations. Altogether, there were eight translocations in sixty males from the first four litters, as against fifteen in fifty-one males from later litters. The difference has a probability of slightly less than 5 per cent of being due to sampling error. For a more elaborate statistical analysis the present results are too scanty. Confirmation on a larger scale is desirable, but cannot be obtained with our present facilities. We hope to be able to provide it at some later time.

Meanwhile, the results presented here, together with Hertwig's[2] and Russell's[3] previously mentioned findings on dominant lethals, offer presumptive evidence for the conclusion that in the mouse, as in *Drosophila*, spermatids are more sensitive to the mutagenic action of X-rays than mature spermatozoa.

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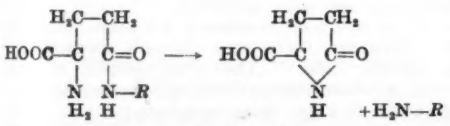
Enzymic Formation of Pyrrolidone Carboxylic Acid from γ-Glutamyl Peptides

PYRROLIDONE carboxylic acid has been reported frequently as a constituent of biological systems. Ellfolk and Synge[1] have summarized these reports and clarified the reliability of methods used for its identification. Pyrrolidone carboxylic acid can be formed rather readily from glutamine, γ-glutamyl peptides, and even glutamic acid in non-enzymic reactions, and in some cases this may account for its reported natural occurrence. For example, Woodward and Reinhart[2] claimed that an enzyme from kidney, later characterized as γ-glutamyl transpeptidase[3], caused the formation of varying amounts of pyrrolidone carboxylic acid from glutathione; but the results of Hird and Springell[4] suggest strongly that the pyrrolidone carboxylic acid isolated by these authors resulted from secondary non-enzymic breakdown of γ-glutamyl peptides under the drastic conditions applied.

In the present work an enzyme has been isolated from liver tissues which does in fact catalyse the formation of pyrrolidone carboxylic acid from glutathione and other γ-glutamyl peptides in accordance with reaction 1:



(1)

This enzyme is quite distinct from γ-glutamyl transpeptidase. It is very active in rat liver, in which tissue the transpeptidase occurs in traces only; and when the two enzymes occur together, as in pig liver, they can be separated cleanly by centrifugal fractionation followed by fractionation with ammonium sulphate. Furthermore, highly active preparations of γ-glutamyl transpeptidase, after appropriate purification, fail to produce even traces of pyrrolidone carboxylic acid detectable by the methods used here.

It is proposed to refer to the pyrrolidone carboxylic acid-forming enzyme as γ-glutamyl lactamase. It will be noted that the cyclic lactam is formed by transfer of the γ-carboxyl group of the glutamyl residue from the peptide linkage to new linkage with the amino-group of this same residue. The enzyme has been shown to act upon γ-glutamylglycine, γ-glutamylglutamic acid, γ-glutamylphenylalanine and glutathione—more slowly upon the last two substrates. The enzyme has no action on glutamine or on free glutamic acid.

In all cases tested the γ-glutamyl peptides are converted completely (within the limits of detection) into pyrrolidone carboxylic acid plus the C-terminal amino-acid or peptide. The purified enzyme is devoid of hydrolytic activity and no free glutamic acid appears during its action. No reversal of the reaction shown in reaction 1 can be demonstrated when the enzyme is allowed to act upon pyrrolidone carboxylic acid plus amino-acids, even when they are present in high concentration; the equilibrium seems to lie far to the right. No pyrrolidone carboxylic acid is detectable when boiled enzyme is incubated with a γ-glutamyl peptide under the usual conditions.

The γ-glutamyl lactamase may be prepared from pig liver in partially purified form as follows: (i) liver tissue, in 3-gm. portions, is macerated in a glass pestle homogenizer in 25 ml. 0·25 *M* sucrose solution; (ii) the homogenate is centrifuged at 105 × gravity in a 'Spinco' centrifuge (model *L*) for 30 min. at 0° C.; the supernatant liquid is dialysed against frequent changes of distilled water in the cold; (iii) the dialysed solution is treated with 2·33 vol. saturated ammonium sulphate solution at *p*H 7·0 and 0° C. (to give 0·7 saturation). After 1 hr. the precipitate is removed and discarded. The supernatant solution is now brought to 0·85 saturation by addition of solid ammonium sulphate. The resulting precipitate is removed on the centrifuge, dissolved in 1/20 of the original volume of water, and the solution is dialysed against distilled water.

During this procedure, a purification of about twenty-fold is achieved. The bulk of the γ-glutamyl transpeptidase is removed in step (ii), and the small amount of this enzyme remaining at the end of step (ii) is removed completely in step (iii).

The action of the enzyme has been studied by chromatography on paper. Samples taken at intervals from enzymic reaction mixtures are killed by heating in boiling water for 1 min. in sealed capillary tubes. (Under these conditions glutamine breaks down to form pyrrolidone carboxylic acid, but no formation of the acid from the different γ-glutamyl peptides used could be detected.) Portions of these samples are spotted on to phosphate-treated chromatograms (No. 3 Whatman paper is dipped into 0·03 *M* sodium phosphate buffer at *p*H 6·7 and dried). The chromatograms are developed using propanol–buffer (80 v./20 v.) as solvent. In this system all constituents of such reaction mixtures (γ-glutamyl peptides, the resulting free amino-acids, and pyrrolidone carboxylic acid) are separated cleanly and reliably. Pyrrolidone carboxylic acid is detected on the chromatograms by means of the chlorine–starch–iodine method[5] as suggested by Ellfolk and Synge[1].

The γ-glutamyl lactamase activity is measured from the chromatograms by the initial rate of liberation of glycine from γ-glutamylglycine, using the method described elsewhere[6]. For this assay the

reaction mixture contains 0·05 mole γ-glutamylglycine, 0·10 mole lithium borate buffer of *p*H 8·0, and usually 50 μl. enzyme solution, the final volume being 200 μl. The presence of γ-glutamyl transpeptidase together with the lactamase is indicated by the formation of the tripeptide γ-glutamyl-γ-glutamylglycine, the course of formation of which may also be followed quantitatively. (The tripeptide runs more slowly than γ-glutamylglycine, whereas glycine and pyrrolidone carboxylic acid run more quickly.)

There have been clear indications for many years that pyrrolidone carboxylic acid is metabolized actively in the animal body[7], and some authors have postulated that it may take the role of an intermediate between glutamic acid and the amino-acids known to be derived from it in the body. Up to the present, however, the evidence has not supported this hypothesis[8]. The demonstrated occurrence of the γ-glutamyl lactamase focuses attention once more upon the interesting problem of the fate of pyrrolidone carboxylic acid in the body since, so far as is now known, this new enzyme catalyses specifically the formation of pyrrolidone carboxylic acid from a common cellular constituent (glutathione) or from other γ-glutamyl peptides which are derived from it in known enzymic reactions.

The programme of which this work forms a part has been supported generously by the J. P. Bickell Foundation. One of us (G. E. C.) held a Fellowship from the National Research Council of Canada, which has supported the work in other ways. We acknowledge our indebtedness to these bodies.

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Paramagnetism of a Reduction Product of Vitamin B_{12}

The fact that vitamin B_{12} is diamagnetic indicates that the cobalt atom in the molecule is trivalent[1]. It can be assumed that it is at a lower valency state in at least some of the products which have been obtained from vitamin B_{12} by reducing agents[2,3]. This has been confirmed by polarographic measurements[4]. However, so far as we know, a direct determination of the valency of the cobalt atom in a reduction product (for example, by magnetic methods) has not been done hitherto.

We began susceptibility measurements on the reduction products of vitamin B_{12} in order to obtain further information on the valency of the cobalt atom in vitamin B_{12} itself, which has been discussed again recently[5]. Furthermore, magnetic investigations, such as have been carried out with hæmoglobin[6] and the catalases[7], seemed desirable since vitamin B_{12} and those substances show structural analogies[8].

The magnetic investigation of vitamin B_{12} presents difficulties, since the starting material is available only in small amounts and the reduction products are unstable. After having developed a micro-method, which was applicable to this special problem and enabled us to work with 100–500 μgm., we were able to show that the reduction product, which has been previously described by Schindler[3], is paramagnetic. An approximate figure for its susceptibility was also determined.

Schindler's[3] procedure, which was adapted to microscale working, was followed. 2–5 mgm. of vitamin B_{12} is dissolved in 500 μl. of 10 per cent aqueous ammonium chloride solution. 60 μl. of this solution is made to react in a sealed tube (100 μl.) with zinc dust (very pure) in a nitrogen atmosphere. The zinc dust is distributed in the solution by rotating the tube. The solution turns brown at first, finally weak greenish-violet or almost colourless. (Schindler mentions a blue colour, but he worked with bigger layers of substance.) The zinc dust is centrifuged off, and the change in susceptibility caused by the reduction is determined immediately. Even in the absence of air the solution is not stable, as can be seen from the colour changes.

The change of susceptibility was determined by our method of 'magnetic balance' (to be described in detail elsewhere). First, the unreacted original solution is 'balanced'. A small sample tube, which holds 40 μl., is filled with this solution and then introduced into a vessel containing cobalt sulphate solution placed between the poles of an electromagnet. When the field is applied, a force is exerted upon the tube, which depends on its mean susceptibility and the susceptibility of the cobalt sulphate solution. Since cobalt sulphate is paramagnetic and water diamagnetic, these forces (for a fixed position of the tube) can be made to balance by varying the concentration of the solution. We then refer to the tube, including contents and solution, as magnetically balanced. After that, the above procedure is repeated with a reduced sample of the same solution. Now the concentration of the 'balancing solution' has to be increased. Consequently the contents of the tube has become more paramagnetic because of the reduction. The change in susceptibility can be calculated from the change in concentration of the balancing solution.

The 'magnetic balance' is determined as follows. The sample is attached to a Cartesian diver, and the whole system is balanced hydrostatically in the cobalt sulphate solution. With this arrangement we have a very sensitive instrument for detecting whether or not the sample tube is magnetically balanced. When the field is applied, movement will occur unless the balancing has been achieved.

One of our solutions contained 3·6 mgm. vitamin B_{12}/ml. (Therefore there were 144 μgm. vitamin B_{12} in the sample tube.) The concentration of the balancing solution (volume 56 ml.) before the reduction was 6·65 mgm. cobalt sulphate per ml. After reduction, another $0{\cdot}15 \pm 0{\cdot}01$ ml. of a solution containing 50 mgm. cobalt sulphate per ml. had to be added in order to rebalance the tube magnetically. The corresponding change of concentration of the balancing solution is 0·13 mgm./ml., and this is equivalent to a change in its volume susceptibility of $8{\cdot}6 \times 10^{-9}$ c.g.s. units. The change in susceptibility of the contents of the tube is proportional to this value. The proportionality factor, which was

determined in separate experiments, is 0·7. Consequently the change in volume susceptibility of the contents of the tube is $6{\cdot}0 \times 10^{-9}$ c.g.s. units and the difference in molar susceptibility between reduced and unreduced vitamin B_{12} becomes $(2{,}300 \pm 200) \times 10^{-6}$ c.g.s. units.

In various experiments values for the difference ranged from $2{,}300 \times 10^{-6}$ to $6{,}800 \times 10^{-6}$ c.g.s. units. These values reflect the extent of the reduction, as well as the degree of decomposition of the reduction product. Solutions which could be considered as completely reduced because of the colour change and the time of reduction showed the greatest increase in susceptibility. Solutions which were still brown in colour (the colour of the intermediate stage) showed changes in susceptibility of only $200–1{,}000 \times 10^{-6}$ c.g.s. units. After standing, the susceptibility always decreases.

By adding the susceptibility of vitamin B_{12} (-750×10^{-6} c.g.s. units) to the values given above, one obtains the molar susceptibility of the reduced form of vitamin B_{12}. The largest value obtained is about $6{,}000 \times 10^{-6}$ c.g.s. units, which corresponds to about 4 Bohr magnetons. (In calculating this value we neglect the contribution of the organic part of the vitamin B_{12} molecule, which may be 10 per cent of the total susceptibility. This is true as long as free radicals are not formed, which is improbable.) The value of 4 magnetons is at the lower limit for compounds containing bivalent cobalt. This, with what we know of the magnetic properties of monovalent and trivalent cobalt, indicates that the cobalt atom in Schindler's reduction product is bivalent.

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Preparation of Tritium-labelled Dihydrostreptomycin

Radioactive streptomycin has been prepared by various investigators by biosynthetic incorporation of carbon-14 in the streptomycin molecule. Their aim has been to study actinomycete metabolism. The purpose of the present investigation was to prepare radioactive streptomycin for autoradiographical studies of its distribution in the body.

Streptomycin adds two hydrogen atoms to its molecule by catalytic hydrogenation. The reduction occurs at the aldehyde group and the resultant dihydrostreptomycin is more stable than its precursor[1].

During hydrogenation, it would be advantageous to dissolve streptomycin in a solvent containing no exchangeable hydrogen, otherwise exchange processes would dilute the tritium content of the gas. No such solvent is, so far as I know, reported in the literature, but it was found that streptomycin is soluble in dimethyl sulphoxide. But in this solvent the hydrogenation went on very slowly for five days and stopped when only about 65 per cent streptomycin was hydrogenated. By the addition of a very small volume of water, the reaction was accelerated and stopped after three days when about 85 per cent was hydrogenated.

A microhydrogenation apparatus, with a hydrogenation bottle of only 1 ml. capacity, was constructed. To avoid isotope effects, heavy water was used in the solvent and deuterium gas to complete the reaction.

In the hydrogenation bottle, 100 mgm. streptomycin was dissolved in 0·05 ml. heavy water and 0·30 ml. dimethyl sulphoxide. 4 mgm. platinum oxide catalyst was added. Tritium gas (1 curie) was allowed to react first; then gradually during three days very small volumes of deuterium gas were transferred to the reaction bottle until the hydrogenation stopped.

The product was isolated by filtration and freeze drying. It was then washed with a rather large volume of water to remove exchangeable tritium from the compound. Only tritium atoms bound to carbon are stable.

Analyses for tritium were carried out by combustion of the organic compound and conversion of the tritiated water to tritium. The tritium gas was then counted by introduction into a Geiger–Müller tube[1]. The specific activity was found to be 0·068 mc./mgm. The accuracy in the determination is estimated at $\pm$ 20 per cent.

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Inactivation of the Adrenal Ascorbic Acid-depleting Activity of Pituitary Extracts by Ascorbic Acid

If extracts of anterior pituitary are incubated for several hours in Ringer's solution containing 1–10 mgm./100 ml. ascorbic acid, their activity on the chromatophores of the isolated skin of *Rana esculenta* disappears[1]. Because of the close chemical relationship between adrenocorticotrophic hormone and intermedin, it seemed of interest to investigate whether the adrenal ascorbic acid–depleting activity of anterior pituitary extracts is also affected by ascorbic acid.

In the following experiments an adrenocorticotrophic hormone preparation of Schering (1 mgm. = 3 I.U.) and ascorbic acid B.P. (Roche) were used; for each group of tests, 0·42 mgm. of the former was dissolved in (*a*) 3·1 ml. pure Ringer (solution *A*),

(*b*) 3·1 ml. Ringer containing 8·4 mgm. ascorbic acid per 100 ml. (solution *B*). Both solutions were kept for 18–20 hr. at room temperature. Then, after requisite dilution with Ringer, the adrenal ascorbic acid – depleting activity of solutions *A* and *B* was estimated by the method of Sayers, Sayers and Woodbury[2]. Female rats which had been hypophysectomized 21–27 hr. before the assay were used. In order to exclude errors from the injection of ascorbic acid when assaying solution *B*, the equivalent amount of ascorbic acid was given to all rats receiving solution *A* immediately after the administration of *A*. The results of the experiments show that the activity of solution *B* on the adrenal ascorbic acid concentration was only 1·9 (0·1 – 4·4, $P = 0.95$) per cent of the activity of solution *A*. In previous experiments the chromatophore-expanding activity of samples of the same batch of Schering adrenocorticotrophic hormone was found also to be reduced to 4 per cent by the same treatment with ascorbic acid. Ascorbic acid dissolved in Ringer's solution, kept for 18–20 hr. and then injected simultaneously with adrenocorticotrophic hormone, did not seem to interfere with the action of the latter on the concentration of ascorbic acid in the rat's adrenal.

That this inactivating effect of ascorbic acid is not due to a general action of this vitamin on all polypeptides was established by the observation that oxytocin, vasopressin and 'substance *P*' (v. Euler and Gaddum) do not lose their activity when incubated with ascorbic acid.

Details of this work will be published elsewhere.

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Propagation of an Air-transmitted Shock Wave in Muscular Tissue

As part of an investigation of the biophysics and physiology of blast injury[1,2], the experiments to be reported here were conducted in order to determine the velocity and damping of a high-explosive shock wave during propagation through a layer of muscular tissue. The velocity of sound in various animal tissues and organs has been extensively studied by Frucht[3]. Concerning the velocity of finite pulses, such as shock waves, no experimental observations are available, and due to the predominance of water in most animal tissues the speed of shock-wave transmission in the body has been supposed to approach that of sound in water[4].

Rectangular pieces of ox thigh muscles (dimensions about 240 mm. × 120 mm. × 60 mm.) were exposed to a high-explosive shock wave in a detonation chamber[1,5]. The time it takes for the wave to cover a known distance was measured by means of two barium titanate crystal pressure-transducers inserted into the meat. The transducer nearest to the explosive charge released the sweep of the recording oscillograph and the distal one recorded the arrival and shape of the wave at the end of the measuring range.

With the low-peak over-pressure used in these experiments (15–30 lb./in.^{2}), the mean velocity of the pressure wave in a covered muscular layer of 170–220 mm. was found to be 650 m./sec., the range being 590–710 m./sec. The relatively great variations are due partly to the inhomogeneous microstructure of the muscular tissue but also to difficulties in determining exactly the arrival of the shock wave at the distal transducer owing to the gradual rise of the pressure curve (see Fig. 1 *B*). The mean velocity during the first 25–50 mm. of propagation was the same as over the whole measuring range, so there was no appreciable slowing down of the wave during the passage of a muscle layer of up to 220 mm.

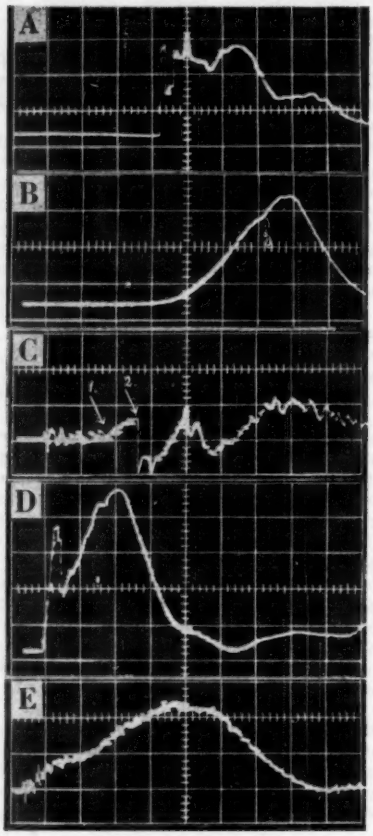

Fig. 1. Recordings of travelling time and pressure curve. Time: 100 μsec. between vertical lines. Pressure: 5 lb./in.^{2} between horizontal lines. The horizontal part of the curves before the increase in pressure corresponds (except in curve *D*) to the passage of the wave through the measuring layer. (*A*) Incident shock wave in air; measuring range, 220 mm.; time of passage, 425 μsec. (*B*) Curve obtained in muscle; measuring range, 200 mm.; time of passage, 330 μsec. (*C*) Differential curve obtained by means of two oppositely coupled transducers, one in the piece of muscle (upward deflexion) and the other in air (downward deflexion), measuring layer with both transducers, 170 mm.; arrows 1 and 2 indicate arrival of wave in muscle and air respectively. (*D*) and (*E*) show steepness of wave-front when the wave has covered a muscle layer of 10 mm. and 25 mm. respectively

The velocity of the incident air shock wave immediately before its impact on the front surface of the meat was 510 ± 10 m./sec. (Fig. 1 *A*).

Due to the inhomogeneity and damping properties of muscular tissue, the steep front of the incident shock wave is already after a very short travel within the meat converted to a wave with a more slowly increasing pressure. In the incident air shock wave,

the time interval between the initial increase of pressure is too short to be determined in the recordings (see Fig. 1 *A*), but it is probably less than 1 μsec. After having passed a muscle layer of only 10 mm. as in Fig. 1 *D*, the interval is about 40 μsec. and already the passage through 25 mm. of muscle may increase the time to several hundreds of microseconds (in Fig. 1 *E* about 420 μsec.). During the further propagation through thicker muscle layers (see Fig. 1 *B*) the time often becomes shorter and the front of the wave steeper again (cf. Fig. 1 *E* and *B*). With increasing peak pressure in the wave, the time of rise tends to become somewhat shorter.

Further investigations are in progress, and a detailed account will be published elsewhere.

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Purine Compounds in Snake Venoms

Fischer and Dörfel[1] identified adenosine in the venom of *Bitis arietans* and *Dendraspis viridis* in concentrations of 12 and 2·6 per cent of the dry weight respectively, and concluded it was a natural component of the fresh venom. In the venoms examined no other nucleoside was found; nucleotides were absent but traces of a guanine compound were not excluded. The present communication reports the identification and estimation of adenosine 3′-phosphate in addition to adenosine in some species of Australian snake venoms.

The Australian snake venoms were dried *in vacuo* over calcium sulphate as soon as possible after collection. These were pooled, powdered and have been stored satisfactorily for immunization studies in stoppered containers over calcium sulphate for periods of up to twenty years at room temperature. Purine compounds were first indicated in a freeze-dried preparation of the fraction of the venom of *Notechis scutatus* soluble in 50 per cent methanol, obtained by the addition of methanol to an aqueous solution of the venom. This fraction in which these substances were concentrated, the whole venom, and the products obtained by dialysis, were examined by paper chromatography using a variety of solvents and the photographic technique of Markham and Smith[2]. Adenosine, adenosine 3′-phosphate and a compound of guanine were identified in three of the eight Australian snake venoms examined. Table 1 shows the relative concentrations found in several samples of each of these and two African venoms.

For quantitative analyses, these compounds were removed from the whole venom by dialysis of aqueous solutions of 2–3 mgm. of the venom, in Visking tubing, against two changes of distilled water and agitation overnight at 6° C. The diffused products were freeze-dried, reconstituted in 0·04 *N* hydrochloric acid and examined in the Beckman spectrophotometer (by courtesy of Dr. R. K. Morton). From the maximum absorption found at 257 mμ, corrected for non-specific absorption, the total concentrations of the purine compounds were calculated in terms of the major component as percentage of the dry weight of the venom, as shown in the last column of Table 1. The differences between the concentrations of adenosine found by Fischer and Dörfel[1] in the venoms of *B. arietans* and *D. viridis*, and those found here in the former venom and the species *D. angusticeps*, may be due in one case to variations between venom preparations and in the other to variations among species of the same genus. The correction for non-specific absorption applied in the above analyses may account for further variation.

Table 1. Concentration of Purine Compounds

Species	Adenosine	Adenosine 3′-phosphate	Guanine compound	Per cent weight*
Notechis scutatus	+ ±	trace ,,	trace —	1·4
Denisonia superba	trace ± ±	+ ± ±	— — —	2·0
Acanthophis antarctica	++ + ++	trace — trace	trace — —	2·4
Bitis arietans†	+++	—	trace	3·8
Dendraspis angusticeps†	+++	—	—	4·3

* Molecular extinction of adenosine and adenosine 3′-phosphate = $14{\cdot}6 \times 10^3$ and $14{\cdot}2 \times 10^3$ respectively (ref. 3*a*).
† Gift from the South African Institute for Medical Research.

Paper chromatography of freeze-dried preparations of the 50 per cent methanol-soluble fraction of *N. scutatus* and the products of dialysis of three venoms (Fig. 1) confirms the identification of adenosine and adenosine 3′-phosphate. The component with R_F close to those of adenosine 2′- and adenosine 5′-phosphate was not identical with either of these substances. The 5′-nucleotidase of *Vipera russellii* venom[4] failed to attack it in eluates from the paper. Using butanol solvents in combination with water, ammonia, or acetic acid, this component exhibited

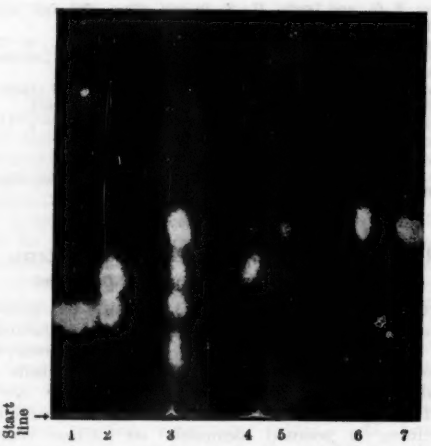

Fig. 1. Photographs of chromatograms. Solvent: sodium dihydrogen phosphate – isoamyl alcohol; ascending.

(1) Adenosine 5′-phosphate; (2) adenosine 3′-phosphate and adenosine 2′-phosphate. (3) 500 μgm. 50 per cent methanol-soluble fraction, *N. scutatus*. (4) – (6) 500 μgm. freeze-dried products of dialysis, (4) *D. superba*, (5) *N. scutatus*, (6) *A. antarctica*. (7) Adenosine.

Note, R_F adenosine 2′-phosphate = R_F adenosine 5′-phosphate

the fluorescence characteristic of guanine compounds on paper chromatograms[6], and showed an absorption maximum near 249 mμ. The R_P value is consistent with that of guanosine 2′- or 3′-phosphate[3b,6]. The zone nearest the solvent front is attributed to a protein complex absorbing in the ultra-violet region.

The question arises as to whether the adenosine 3′-phosphate and adenosine are natural constituents of fresh venoms or are formed after venom secretion by enzymic action on some precursor. If nucleic acids were their source other bases should have been detected. Of the known coenzymes, only coenzyme *A* could give rise directly to both adenosine 5′- and adenosine 3′-phosphates. However, as the rates of attack by both the 5′-nucleotidase of snake venoms[4] and unspecific phosphatases[7] are considerably faster for the 5′- than the 3′-configuration, one would expect to find adenosine 3′-phosphate in venoms more frequently. In the absence of other evidence it would appear that adenosine, adenosine 3′-phosphate and possibly guanosine 2′-(or 3′-)phosphate are natural constituents of snake venoms (see also Fischer and Dörfel[1]). The direct secretion into milk of enzymes, nucleotides and other metabolic intermediates from the mammary gland is well established[8], while dinucleotides of 2′–5′- and 3′–5′-configuration are now recognized to occur in some tissues[9]. It is therefore suggested that the purine compounds of snake venoms arise directly from the venom glands, which may well yield nucleotides additional to those already identified in the glandular secretions.

I thank the director, Dr. F. G. Morgan, and Dr. J. J. Graydon, of these Laboratories, who made the venoms available, Misses J. Pearson and F. Bates for technical assistance and Mr. K. Rowan for helpful advice. Dr. R. K. Morton made valuable suggestions and collaborated in the preparation of this communication.

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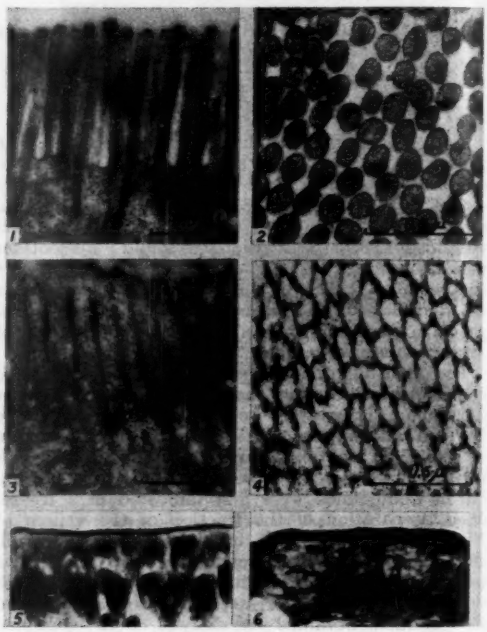
Histochemical Techniques for Electron Microscopy: Alkaline Phosphatase

Application of histochemical methods to electron microscopy is a logical development of biochemical and biophysical techniques. The comparatively limited resolution of the light microscope fails to reveal the relationship of normal cellular ultrastructure to the sites of histochemical reactions. Therefore, it seemed desirable to utilize recent developments in electron microscopy of biological material[1] in the hope of learning more about the structures demonstrated with these techniques.

An electron microscope study at high resolution (better than 30 A.) of the intestinal epithelium of the mouse has demonstrated that the brush border is composed of minute parallel cylindrical projections of the cytoplasm about 1 micron long and 0·1 micron wide. These projections are bounded by the cell membrane, which appears as two dense lines each 40 A. thick separated by a non-dense area of 25 A. The cell membrane is an unbroken unit covering each projection and continues to adjacent projections without any discontinuities, either at the apices or the base of the projections (unpublished observations by H. Z.).

High concentrations of the enzyme alkaline phosphatase have been demonstrated in the epithelium of the intestinal mucosa by the method of Gomori[2] and Takamatsu[3], where the reaction is demonstrable principally in the brush border zone[4], and also in the Golgi region[5].

The histochemical demonstration of alkaline phosphatase is based on the principle that if enzyme-containing tissue is incubated with glycerophosphate at approximately *p*H 9 in the presence of calcium ions, the phosphate ions liberated will be precipitated at the site of formation as insoluble calcium phosphate. These sites may then be demonstrated by the method of von Kóssa; in this method the precipitated calcium phosphate is transformed into silver phos-



(1) Electron micrograph of mouse intestinal epithelium fixed 2 hr. in 1 per cent isotonic osmium tetroxide solution. Longitudinal section of brush border. × 24,000.

(2) Electron micrograph of mouse intestinal epithelium fixed 2 hr. in 1 per cent isotonic osmium tetroxide solution. Cross-section of brush border. × 35,000.

(3) Electron micrograph of mouse intestinal epithelium fixed 8 min. in 1 per cent isotonic osmium tetroxide solution, incubated 120 min. in Gomori's alkaline phosphatase substrate. Longitudinal section of brush border; positive reaction indicated by dense granular precipitate. × 28,000.

(4) Electron micrograph of mouse intestinal epithelium fixed 8 min. in 1 per cent isotonic osmium tetroxide solution, incubated 30 min. in Gomori's alkaline phosphatase substrate. Cross-section of brush border; positive reaction indicated by dense granular precipitate. × 35,000.

(5) Light micrograph of mouse intestinal epithelium fixed 2 hr. in 1 per cent isotonic osmium tetroxide solution. × 1,000.

(6) Light micrograph of mouse intestinal epithelium fixed 10 min. in 1 per cent isotonic osmium tetroxide solution, incubated in Gomori's alkaline phosphatase substrate for 30 min. Positive reaction in brush border. × 1,000

phate, which is readily visible in electron micrographs as a dense granular precipitate.

For these experiments, in order to avoid the inhibition of the enzyme by the osmium tetroxide fixative routinely used for electron microscopical preparations, tissues were fixed briefly (8 min. or less) in 1 per cent buffered isotonic osmium tetroxide, washed in Tyrode's solution and incubated in Gomori's alkaline phosphatase mixture for 30 and 120 min. at 37° C. The precipitate of calcium phosphate was demonstrated by immersion in 0·5 per cent silver nitrate for ten minutes, after which the tissue was washed several times in distilled water. This was followed by graded alcohol dehydration and embedding in methacrylate. Controls were run by incubating tissues in substrate containing 0·02 *M* cyanide.

Electron micrographs of thin sections from the histochemical preparations showed a dense granular precipitate of silver phosphate distributed uniformly in intercylindrical spaces of the projections of the brush border. In sections through the cylindrical projections parallel or tangential to the cell surface the granular precipitate was arranged like a honeycomb, the cylindrical projections appearing non-dense and the interspaces dense. Preliminary work does not elucidate the relation of the reaction to the cell surface membrane.

Cyanide-inhibited controls showed a normal structure without the granular precipitate, eliminating the possibilities of a false positive reaction. With the short periods of incubation employed, the possibility of diffusion artefacts was minimized[6].

Further investigations with such techniques should prove useful in determining a more precise locus of histochemical reactions than has been possible with light microscopy and may yield information about the true loci of enzymes.

We thank Dr. F. S. Sjöstrand for the privilege of working in his laboratory.

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Complementary Action of Melibiase and Galactozymase on Raffinose Fermentation

On the basis of experimental investigations on the inheritance of hydrolytic and fermentative ability in yeasts, we have been led to the conclusion that an exact knowledge of the genotype of the organism employed is not only desirable but also necessary if the processes of hydrolysis and fermentation are to be studied in detail. Since the existence of six different genes (M_1, M_2, M_3, M_4, M_5 and M_6) responsible for the hydrolysis and subsequent fermentation of maltose has been demonstrated in yeasts (Winge and Roberts[1], Gilliland[2], and Winge and Roberts (unpublished work)), and since these genes are not biochemically identical—for example, M_1 hydrolyses both maltose and sucrose and M_2 hydrolyses maltose alone—it is necessary, through appropriate hybridizations and segregations, to isolate each gene individually in a single cultural type in order to investigate the activity of the enzyme synthesized by that particular gene. Otherwise, the presence of additional hydrolytic genes in the culture under investigation may well lead to a confused interpretation of the experimental results.

At present we have isolated, each in a different cultural type, the following genes responsible for the synthesis of hydrolytic enzymes: six maltose-hydrolysing genes, M_1–M_6 (M_5 was, however, isolated by Gilliland), three raffinose- and sucrose-hydrolysing genes, R_1–R_3, and one melibiose-hydrolysing gene, *Me*. In addition, we have isolated two galactose-fermenting genes, *G* and g_s, which bring about rapid and slow fermentation, respectively.

According to the well-known observation of Kluyver, those yeasts which are capable of fermenting at all will always ferment the monosaccharides glucose, fructose and mannose, but not all fermenting yeasts are able to ferment the monosaccharide galactose.

Barring the occurrence of mutation or of nuclear irregularities during spore formation (Winge and Roberts[3]), a yeast hybrid produced by artificially crossing two cultures differing by one fermenting gene will segregate out two fermenting to two non-fermenting single-spore cultures in each of its four-spored asci.

During an investigation of the R_2-gene, which hydrolyses raffinose in such a way that the fructose portion of the molecule is liberated and afterwards fermented, while the melibiose portion remains intact, we produced a series of R_2r_2-hybrids. All the tetrads of these hybrids were expected to segregate out as $2R_2 : 2r_2$, that is, two single-spore cultures capable of fermenting raffinose and two non-fermenting single-spore cultures. The segregations obtained, however, were most surprising in that we found, of a total of 119 tetrads from five different R_2r_2-hybrids, the following:

$4R:0r$	$3R:1r$	$2R:2r$
4	68	47

This was not a one-gene segregation, nor was it a typical two-gene segregation, in which the frequency of the segregations 4 : 0, 3 : 1, and 2 : 2 should theoretically occur in the ratio 1 : 4 : 1. A two-gene segregation, however, could not be expected to occur since the hybrids contained R_2 alone.

A series of planned genetic experiments finally led to an explanation of these segregations. We were aware that all five hybrids were also heterozygous with respect to both the melibiase and galactozymase genes, so that their genotype could be written as R_2 *Me G*/r_2 *me* g_s. Our working hypothesis, which proved to be correct, assumed that the complementary action of *Me* + *G* results in the fermentation of one-third of the raffinose molecule, the galactose portion being fermented away by galactozymase and the sucrose portion remaining intact. If, however, R_2 is also present, then the raffinose molecule is completely fermented due to the hydrolysis of sucrose into fructose and glycose by β-*h*-fructosidase.

Our segregation results showed that the melibiase gene and the galactozymase gene were weakly linked. Assuming the existence of complementary genes and of approximately 40 per cent crossing over, then

the theoretically expected raffinose segregations (1 : 19 : 16) of the 119 asci are as follows :

4 *R* : 0 *r*	3 *R* : 1 *r*	2 *R* : 2 *r*
3·3	62·8	52·9

which, as can be seen, are in satisfactory agreement with the segregations actually obtained.

The final proof of the correctness of this hypothesis of complementary action would naturally consist in the genetic analysis of a hybrid which had been produced by crossing an *Me* g_s genotype with an *me G* genotype, neither of which contained any other hydrolytic or fermentative genes (except, of course, the zymase complex for glucose fermentation). These two parent types would each be unable to ferment raffinose, but the hybrid, *Me* g_s/*me G* should, according to the hypothesis, be able to hydrolyse raffinose and ferment the liberated galactose, resulting in a one-third raffinose fermentation.

Eight hybrids of this genotype (*Me* g_s/*me G*) were produced. Each of them was capable of fermenting raffinose after four to seven days.

Even more interesting were the segregation ratios obtained from the offspring of one of these hybrids. Theoretically, the spore tetrads from an *Me* g_s/*me G* hybrid should yield the following results :

Relative frequency	Type of tetrad	Raffinose fermentation
1	2 *Me G* : 2 *me* g_s	2+ : 2−
1	2 *Me* g_s : 2 *me G*	0+ : 4−
4	1 *Me G* : 1 *Me* g_s : 1 *me G* : 1 *me* g_s	1+ : 3−

Six asci from one *Me* g_s/*me G* hybrid were analysed ; of these, five gave a 1 : 3 raffinose segregation and one gave a 2 : 2 raffinose segregation. All the seven raffinose-fermenting single-spore cultures fermented both melibiose and galactose (the latter rapidly), while none of the remaining seventeen single-spore cultures was able to ferment both sugars.

On the basis of these results, we propose the following scheme for the gene action responsible for the hydrolysis and fermentation of the raffinose molecule (Fig. 1).

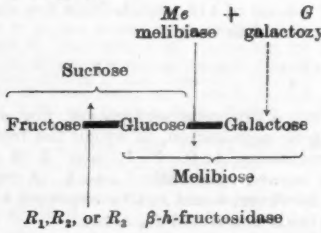

Fig. 1. Gene action involved in the hydrolysis and fermentation of the raffinose molecule

It can be seen that raffinose may be hydrolysed through the activity of R_1, R_2, or R_3 into melibiose and fructose, the latter being fermented by the zymase complex present in all fermenting yeast cells. On the other hand, raffinose may also be hydrolysed through the activity of the *Me*-gene into sucrose and galactose, the latter being fermented by galactozymase. Mr. Manuel Losada, of Madrid, has assisted us by demonstrating that the *Me*-gene in the absence of the *G*-gene is capable of hydrolysing raffinose, in that after growth of an *Me r* yeast type in a raffinose medium the substrate reduces Fehling's solution, thus showing the presence of galactose. As a control, an *me r* yeast type was grown in the same medium ; here Fehling's solution was not reduced.

It is for this reason that we speak of complementary gene action with respect to raffinose fermentation rather than raffinose hydrolysis. The latter process is carried out by the *Me*-gene alone ; but in order to ferment the raffinose molecule by complementary gene action, *G* must be present together with *Me*.

Finally, it should be mentioned that the gene g_s, which requires long-term adaptation in order to bring about the fermentation of galactose (Winge and Roberts[4]), is also responsible for the slow fermentation of raffinose in co-operation with *Me*. It has also been established that the fermentation of raffinose through the action of the *R*-genes (to the left in Fig. 1) takes place more rapidly than the fermentation of raffinose through complementary action, presumably because fructose may be fermented more rapidly than galactose.

A detailed account of these investigations will appear in the *Comptes Rendus des Travaux du Laboratoire Carlsberg*.

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Chromosome Number in Rabbit Blastocysts

During recent years a series of papers have appeared discussing the constancy or inconstancy in the chromosome number in mammalian tissues. It is now generally agreed that some tissues show a certain degree of inconstancy in the chromosome number either by having aneuploid cells[1] or by developing more constant euploid (or polyploid) cells[2]. I have shown[3] that by careful attention to technique, including pre-treatment in hypotonic saline solution and using a gentle squash, about 95 per cent of the cells in rabbit blastocysts (five days old) will appear normal with $2n = 44$, whereas 2–3 per cent have hypo- or hyper-ploid numbers. The reason for low numbers seems in many cases to have been mechanical disturbances introduced by the squash technique.

In a review of the chromosome number in mammalian somatic cells, Beatty[4] raises the question, how early in life the inconstancy originates. Beatty (in collaboration with M. Fischberg) found from haploid to tetraploid cells and few hexaploid cells in mouse blastocysts as early as 3½ days after fertilization. We have examined rabbit blastocysts of five days of age and found the results already mentioned. However, it is of interest to try to find whether the heteroploid cells appear only in certain tissues or if they can arise anywhere in the young embryos. By the way, attention is directed to the fact that in most cases the inconstancy in chromosome numbers has been found in dying tissues and in transitory embryonic membranes (cf. refs. 4, 5). In the following, results are presented of an attempt to count the chromosomes in two different parts of the rabbit blastocyst, described simply as the trophoblast and the embryonic disk.

Due to the small size of the five-day blastocyst, specimens six days old were used in this case. The blastocysts were washed out from the uterine horns and immediately placed in an incubator at 37° C. in a 0·45 per cent saline solution, according to the routine method now used in our laboratory[6]. After pre-treatment, the specimens were fixed in alcohol – acetic acid for 1 hr. and stained according to the Feulgen method for at least 20 min. After staining, a single blastocyst was placed in glycerine in a hollow-ground slide (hanging drop slide), and by use of a micromanipulator the embryonic disk was separated from the trophoblast layer. The two parts were then squashed on separate slides, applying only very gentle pressure. The trophoblasts were more difficult to handle than the embryonic disks.

Twenty-six blastocysts were used, and 104 metaphase plates could be counted from embryonic disks, of which 101 plates had $2n = 44$, one had 41 chromosomes while two plates had clearly 66 chromosomes. From the trophoblast cells, 46 plates were counted. One cell had only 33 chromosomes, four cells had 41 chromosomes each and 41 cells had $2n = 44$ chromosomes. Although a χ^2-analysis shows a small difference ($P < 0·05$) in the distribution of the number of cells with deviation in chromosome numbers between trophoblast and embryonic disk cells, this is not regarded as of significant importance, and it is concluded that aneuploid or polyploid cells appear with the same frequency in the two parts of the blastocyst examined up to the age of six days. It should be mentioned that the total number of abnormal cells—although few—is of the same magnitude, namely, 5 per cent, as found in the earlier work[3].

I am indebted to Mr. Per-Jonas Åström for his valuable help throughout this work.

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Selection for Heterozygotes during Inbreeding

Rye is normally an outbreeding species. When the plants are forced to inbreed by self-pollination, the progeny, being more homozygous, are, as is usual in such species, less vigorous and less fertile than the heterozygotes which comprise a normal population. Since heterozygotes are superior in this way to the homozygotes, it could be expected that, during the course of inbreeding, natural selection would favour to some extent the more heterozygous genotypes. To test this assumption, we have made use of chromosome structural changes where genotypes heterozygous and homozygous for the chromosome segments involved are easily distinguished.

In 1950 an F_1 plant from a cross between two inbred lines was found to be heterozygous for two separate and distinguishable interchanges, *A* and *B*. This F_1 plant was self-pollinated. From the F_2 generation three of the plants which were heterozygous for both the interchanges were selfed and the inbreeding was continued in subsequent generations by selfing a double heterozygote in each of the three families. As a result of inbreeding depression, the proportion of the seeds sown which reached maturity was generally low from F_2 onward and in no family was it higher than 77 per cent. Samples of the mature plants were scored at meiosis. In the absence of selection, the progeny from selfing a plant heterozygous for two separate interchanges would be expected to consist of four equal classes in respect of structural homozygosity and heterozygosity, namely, Hom. *A* Hom. *B*, Hom. *A* Het. *B*, Het. *A* Hom. *B*, Het. *A* Het. *B*. Selection for or against one or both heterozygotes will upset this ratio. The distributions observed in the four inbred generations are given in Table 1.

Table 1. Distributions of Homozygotes and Heterozygotes in Respect of Two Interchanges, *A* and *B*. Each Family is Derived from Selfing a Double Heterozygote

	Family	Hom. *A* Hom. *B*	Hom. *A* Het. *B*	Het. *A* Hom. *B*	Het. *A* Het. *B*
F_2		5	9	11	7
F_3	1	1	1	2	4
	2	5	5	8	4
	3	5	3	6	5
F_4	1	3	4	9	13
	2	8	6	10	10
	3	0	1	7	7
F_5	1	2	5	4	2
	2	2	1	3	5
	3	2	0	1	5
	Total	33	35	61	62

Contingency χ^2 analyses of these results show (1) no significant heterogeneity between generations or families, and (2) the interchanges to be distributed independently of one another. The results from all generations may therefore be pooled and the interchanges analysed separately. The distributions in respect of *A* and *B* in the total progeny are:

	Hom.	Het.	Total
Interchange *A*	68	123	191
Interchange *B*	94	97	191

The distributions of *A* and *B* are significantly different ($\chi^2_{[1]} = 7·246$, $P = 0·01–0·001$). The proportion of homozygous to heterozygous *B*'s is not significantly different from the 1 : 1 ratio expected when neither class is at a selective advantage. In the case of *A*, however, there is a significant excess of heterozygotes. We conclude from this that the genotypes heterozygous for interchange *A* enjoy a selective advantage over the homozygotes. It is to be noted that the selection operates in favour not of heterozygotes in general but of a particular heterozygous combination, which indicates that heterozygosity in itself is not necessarily advantageous. These conclusions agree with Darlington and La Cour's findings[1] in *Campanula*, a species in which interchanges are commonly found in wild populations. A selective advantage of structural (inversion) heterozygotes is, of course, well known from the work of Dobzhansky[2] and his collaborators, and others[3], in *Drosophila*. White[4] also has concluded that certain chromosome structural heterozygotes are at an advantage in populations of grasshoppers.

An excess of heterozygotes could possibly be interpreted in terms of a major gene showing some degree of lethality in a homozygous state. A phenotype with yellowish leaves in the seedling stage which appeared during the course of this experiment was

probably determined by a recessive gene of major effect. All those examined were found to be homozygous for interchange *A*, from which we conclude that the gene is located on one of the chromosomes involved in this interchange. It is clear, however, that this major gene difference does not account for the excess of heterozygous *A*'s, because the homozygous *A* plants which are 'yellow' survive as well as those which are green. The ratio of the two types was in fact 16 'yellow' to 11 green. Although we cannot entirely rule out the possibility of some major gene affecting the results, an alternative, and more likely, explanation is that the advantage of the *A* interchange heterozygotes is due to a superior balance of polygenes in heterozygous combinations. We can therefore make use of these interchanges for genetic investigations of rye populations in much the same way as inversions have been used by Dobzhansky in *Drosophila*.

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Chromosomal Polymorphism in a Bark Weevil

The North American bark weevil, *Pissodes approximatus* Hopk., has three different chromosome numbers, namely, 30, 31 and 32, due to what White[1] has called 'centric fusion' of non-homologous autosomes. The 'fusion' homozygote consequently has two large V-shaped chromosomes instead of four smaller rod-shaped chromosomes, and the 'fusion' heterozygote has one V and two rods that form a trivalent in primary spermatocytes (Fig. 1).

Although chromosomal polymorphism of this type is well known in the Orthoptera[2], mainly no doubt because the order has received considerable attention from insect cytologists, this constitutes the first recorded example of the phenomenon among the five hundred or so beetles that have been examined to date. It is nevertheless quite certain that almost 10 per cent of the species have evolved neo-*XY* sex chromosomes through 'centric fusion' of the *X*-chromosome with an autosome, their mode of origin being revealed in the heterogametic male by the morphology and differential staining of the sex-determining complex. However, that the process, as confined to autosomes, must have contributed in large measure to the multiplicity of chromosome numbers found in the Coleoptera[3] is attested by the number of cognate species and neighbouring genera in which the one with the lower chromosome number has a relatively large pair of autosomes. Nevertheless, until this direct demonstration, their true mode of origin has been a matter of inference.

So far, a total of sixty-seven adults, mostly males, have been examined from widely scattered areas in Ontario. At least two of the three types occur in each area, but none has been studied intensively enough to test for deviation from the Hardy–

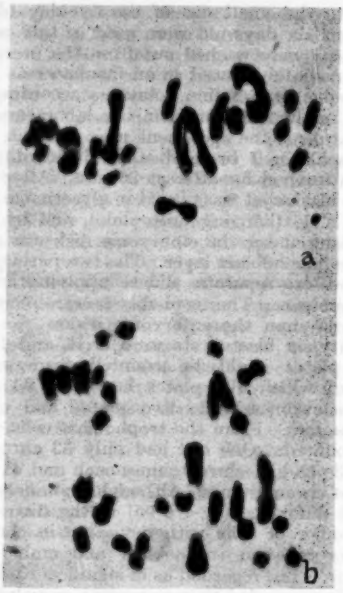

Fig. 1. Primary spermatocytes in *Pissodes approximatus*. (*a*) first metaphase: 13II + 1III + *XY*; (*b*) first anaphase. (× about 2,300)

Weinberg equilibrium. However, since the species apparently breeds at random in well-defined populations, an investigation of their genetical dynamics may be expected to reveal much of the mode of operation of natural selection under different environmental conditions and elucidate the problem of the genetical evolution of populations and geographical races of insects.

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Nucleus and Spindle of *Bacillus megatherium* in Fission and Sporulation

The cells of *Bacillus megatherium* have been stained by DeLamater[1], Fitz-James[2], Robinow[3] and others with various dyes to show the chromatin-threads after pretreatment with perchloric acid, chloric acid or other reagents. Chromosomes have been observed occasionally in mitosis as well as a structure which I identify with the spindle described by Lindegren *et al.*[4] in the yeast cell. The large ellipsoidal nucleus containing the chromosomes in the centre of the bacterial cell can be observed in the living cell. This structure is identical with that which DeLamater[1] observed in stained material of *Bacillus megatherium* and which Whitefield and Murray[5] observed in stained cells of *Shigella dysentriae*. The chromosomes appear when dried (unheated) bacterial smears are stained with 1 per cent aqueous gentian violet. They are not clear when stained directly with Giemsa solution but stain clearly with Giemsa after pretreatment with 10 per cent perchloric acid for 20 min. (Fig. 1,*a*).

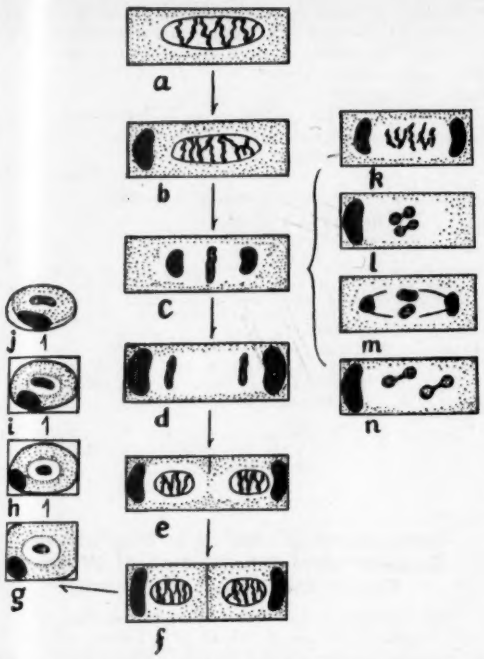

Fig. 1. Schematic representation of *Bacillus megatherium*. (*a*) Resting nucleus, (*b*) prophase, (*c*) metaphase, (*d*) anaphase, (*e*, *f*) telophase, (*g*–*j*) spore formation, (*k*–*n*) various figures of metaphase

The chromosomes are Feulgen-positive (1) after fixation with 75 per cent alcohol, or (2) Carnoy's fluid, or (3) after pretreatment with 10 per cent perchloric acid for 20 min., or (4) without fixation.

A large body on one side of the nucleus stains directly (1) with iron aceto-carmine solution, (2) with 1 per cent aqueous gentian violet, (3) with Giemsa, or (4) with 0·1 per cent aqueous vital red—but it is Feulgen-negative. It seems to appear when the cell enters prophase. After pretreatment with 10 per cent perchloric acid it is stained by either gentian violet or Giemsa. It corresponds to the spindle of the yeast cell[4], although its staining reaction is somewhat different. It is inferred to be the spindle from consideration of its behaviour in mitosis. It corresponds to what Robinow and Murray[6] named "the deeply stained cytoplasm" in *Bacillus cereus*. I identify this structure as the spindle-body.

Small granules often appear in the cell after staining with 1 per cent aqueous Janus green which are thought to be chondriosomes.

When the mitosis begins a single spindle-body appears at one end of the cell (Fig. 1,*b*), and as mitosis proceeds (Fig. 1,*c*–*e*,*k*,*m*) two spindle-bodies appear, one on each side of the nucleus. Between the two spindle-bodies the chromosomes change into one or two blocks of unresolvable chromatin (Fig. 1,*c*,*l*,*m*,*n*). At telophase a separation-wall is formed; each daughter cell contains one nucleus and one spindle-body (Fig. 1,*e*,*f*).

Preceding spore formation the cell divides transversely into a chain of smaller cells. The protoplasm of each small cell becomes ellipsoidal with the nucleus in the centre (Fig. 1,*g*,*h*). The large body in the cytoplasm beside the nucleus (Fig. 1,*g*,*h*) was called the 'peripheral body' by Fitz-James[2] and the 'side-body' (in the *Bacillus cereus*) by Fitz-James, Robinow and Bergold[7]. Each ripe spore contains a large 'side-body' and a nucleus in the centre of the cytoplast (Fig. 1,*i*,*j*). The 'side-body' corresponds to the 'eccentric nucleus' observed by Robinow[3].

The nuclear vacuole with its enclosed chromatin was called the 'basophilic ring' by Fitz-James[2] and the 'basophilic central core' by Fitz-James, Robinow and Bergold[7].

Only the spore coat of the spore stains with 1 per cent aqueous gentian violet or Giemsa, but after pretreatment with 10 per cent perchloric acid, both the nucleus and the 'side-body' are stained. Usually after pretreatment with 10 per cent perchloric acid only the chromosomes are Feulgen-positive, but occasionally the 'side-body' is Feulgen-positive because deoxyribonucleic acid of the nucleus has been retracted on to the 'side-body' (spindle).

In spores fixed with 45 per cent acetic acid or Carnoy's fluid and then stained with 1 per cent aqueous gentian violet (after pretreatment with 10 per cent perchloric acid for 20 min.) the 'side-body' and the chromosomes stain deeply, indicating that the 'side-body' and the nucleus are independent structures and that the 'side-body' is identical with the spindle-body.

I wish to express my cordial thanks for providing facilities for the present study and for criticism of the manuscript to Prof. Carl C. Lindegren, chairman of the Department of Microbiology, Southern Illinois University.

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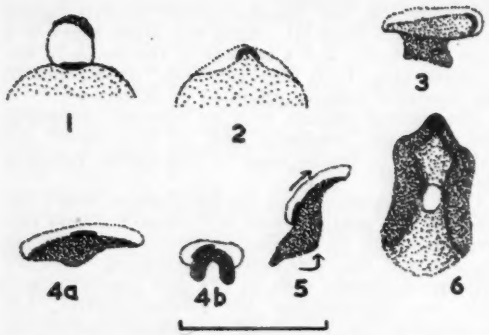
Acrosome Formation in Bandicoot Spermiogenesis

THERE has been some disagreement about the presence of an acrosome in marsupial spermatozoa. Students of spermiogenesis[1] are generally agreed that none is present, whereas Retzius[2] found a diminutive body at the proximal end of the mature sperm head in some species, although not in *Didelphys*[3]. As Bowen[4] remarked, such apparent exceptions to the universal presence of an acrosome in animal sperm are important. A study of spermiogenesis in the bandicoot (*Parameles nasuta*), previously reported to lack an acrosome by Benda[1], has shown that an acrosome is indeed present, although its method of formation presents some unique features. For study of the process, specific staining[5] by the periodic acid – Schiff procedure[6] was essential. The staining was preceded by digestion with saliva and followed by staining with toluidine blue. With classical methods it was impossible to be certain of the presence of an acrosome at any stage.



Figs. 1–6. Camera lucida drawings of the acrosome of the bandicoot at various stages of development. The granular component is solid black, the archoplasmic vacuole is unshaded, while the nucleus, except for the nuclear aperture in Fig. 6, is stippled. Figs. 4*a* and 4*b* are lateral and polar views, respectively, of cells at the same stage of development. The upper margin in all figures, except 1, is directed towards the Sertoli cell. The scale beneath the figures represents 10μ (Figs. 1–5) or 6·8μ (Fig. 6)

As in other animals[4,7], a vacuole is formed in the archoplasm relatively early in spermatic development and within this vacuole a small granule is laid down. Almost immediately, this granule becomes applied to, and flattened against, the nuclear membrane (Fig. 1). No further growth of the flattened granule, later to become the granular component of the acrosome, occurs. An outgrowth from the nucleus diminishes, and finally appears to close, the vacuole (Fig. 2).

Owing to the peculiar process of nuclear condensation, the granular component is carried to a point at one side of the now flattening nucleus (Fig. 3). This point marks the future proximal end of the sperm head. During the nuclear condensation the vacuole again becomes evident; with further condensation and flattening of the nucleus, it becomes considerably lengthened and increased in volume. At the same time the granular component becomes dislocated from its previous position and is now found at a variable position on the dorsal surface of the much flattened and now partially folded nucleus (Fig. 4 *a*,*b*).

After rotation of the nucleus through 90°, a process which brings its long axis radial with respect to the seminiferous tubule and in line with the axial filament, the vacuole becomes reduced in volume and moves towards the proximal end of the nucleus. During this shrinkage of the vacuole the granular component is carried along the dorsal surface and towards the proximal end of the nucleus, by now almost transformed into the mature sperm head (Fig. 5). The granular component finally comes to rest at the tip of the rostrum of the mature sperm head (Fig. 6). Here it forms a conical cap of diameter 1·4μ, height 0·6μ and thickness 0·3μ. The shrinking vacuole becomes attached to the base of the conical rostrum of the sperm head, finally forming what corresponds to a dorsal head cap, although not normally visible as such. Thus both the granular and vesicular derivatives of the archoplasm contribute to the formation of the acrosome in the mature sperm.

Acrosome formation in the bandicoot is unusual in a number of respects: (1) the absence of growth of the granular component, which is normally merely a proacrosome; (2) the earlier hypertrophy, very late condensation, and changing insertion of the archoplasmic vacuole; (3) the dislocation of the granular component of the acrosome from its original position. The latter is quite different from the complex migrations undergone by the proacrosome in some Hemiptera[8].

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Components of the Total Magnesium Content within the Leaves of White Clover and Perennial Ryegrass

Little information exists concerning the quantitative relationships between the forms in which magnesium exists within leaves. Chlorophyll concentrations in leaves have frequently been measured[1], but rarely has this been done simultaneously with estimations of the total magnesium content.

Fully green leaves of perennial ryegrass (*Lolium perenne*) and *S*100 white clover (*Trifolium repens*) were gathered from plants growing in the field on Sept. 20, the petioles of the clover leaves were removed, and approximately 2 gm. of fresh material was extracted in 80 per cent acetone. The residual colourless material was designated 'fibre'; the ryegrass residue looked like cotton wool, that from the clover was more powdery and less fibrous.

The chlorophyll concentration in the solution was determined on a Unicam *S.P.*500 spectrophotometer by the method of MacKinney[2], whose values for the molecular extinction coefficient of chlorophyll *a* and chlorophyll *b*, in acetone at 6630 A. and 6450 A., were confirmed by Holt and Jacobs[3]. In this determination the assumption was made that no compounds in the solution other than chlorophyll *a* and chlorophyll *b* were absorbing light at 6630 A. and 6450 A. The total magnesium concentrations in the fibrous fraction and in the original material were determined, after ashing at 550° C., by the method of Mason[4].

The 'chlorophyll magnesium' was calculated from a knowledge of the formulæ of chlorophyll *a* and chlorophyll *b*, and the values obtained for the ratio chlorophyll *a*/chlorophyll *b*. The magnesium which could neither be attributed to the chlorophyll molecule nor existed within the fibre fraction was designated 'residual magnesium' and was probably mostly soluble in water.

In Table 1 results are given comparing the composition of the leaves of ryegrass and clover. In Table 2 are values of the proportions of the various forms of magnesium (as percentages of the total magnesium content) within these same two types of leaf. All values are the mean of three replicates.

Table 1. Composition of Leaves of Clover and Ryegrass

	% Dry matter (fresh wt. basis)	% Chlorophyll (fresh wt. basis)	% Chlorophyll (dry wt. basis)	% Fibre (dry wt. basis)	% Mg in leaf (dry wt. basis)	% Mg in fibre (dry wt. basis)	Chlor. *b* / Chlor. *a*
White clover	19·4±0·06	0·219±0·001	1·13±0·02	65·52±1·08	0·2365±0·0004	0·1478±0·0019	1 : 2·88±0·052
Perennial ryegrass	16·9±0·22	0·199±0·002	1·18±0·02	70·63±0·26	0·1803±0·0035	0·0960±0·0056	1 : 3·07±0·039

Table 2. Distribution of Leaf Magnesium as Percentage of Total Magnesium Present

	In fibre	In chlorophyll	Residual magnesium (by subtraction)
White clover	62·47±0·64	12·86±0·03	24·67±1·00
Perennial ryegrass	53·29±2·71	17·75±0·61	28·96±2·94

These results indicate that both the maximum concentration of chlorophyll (0·20 per cent fresh weight basis) and the ratio of chlorophyll *a* to chlorophyll *b* (2·5 : 1) given by Hill and Whittingham for green leaves[1] may be exceeded in ryegrass and clover.

Also the fact that more than 50 per cent of the magnesium in these two types of leaf is located within the 'fibre' fraction may affect the availability of this element to animals feeding on these two pasture plants. This in turn may be of significance in the study of the incidence of hypomagnesæmia[2] in the grazing animal.

Grateful acknowledgments are made to Drs. R. Hill and A. E. Flood for advice, and to the Central Research Fund of the University of London.

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Nasal Trichobilharziasis : a New Avian Schistosomiasis

In the course of research on the schistosomes of birds in the Belgian Congo and in the Ruanda-Urundi, I have discovered schistosomes in the nasal cavities of birds[1]. Nasal schistosomiasis is known to affect cattle in India, but it does not seem to have been mentioned in birds.

All parasites that were discovered—there being five new species—belong to the genus *Trichobilharzia* Skr. and Zakh. (1920). Nasal schistosomiasis is very common in the Anatidae. At Astrida (Ruanda-Urundi) we have observed it in the yellow-bill duck (*Anas undulata undulata*), in the spurwing goose (*Plectropterus gambensis*), in the Egyptian goose (*Alopochen aegyptiacus*), in the white-faced duck (*Dendrocygna viduata*) and in the knob-billed duck (*Sarkidiornis melanota*). Further, we have also met it in the Hadeda ibis (*Hagedashia hagedash* Ciconiiformes) and in the grebes (*Podiceps* and *Poliocephalus*).

The adult schistosomes are found in the small veins of the nasal cavities, and the eggs, often in great numbers, are met with in the nasal mucus. It is remarkable that the *Trichobilharzia* of the nasal cavities are exclusively found in these organs, and never in the liver or in the intestinal veins.

The histopathological lesions consist in a thickening of the nasal lining together with an accumulation—often considerable—of lymphocytes and the presence of numerous and voluminous giant cells. Sometimes additional infection is noted together with necrosis.

The discovery of this schistosomiasis opens a new field of research to the parasitologist, and promises to be fruitful. It is also of considerable interest from the medical point of view. Indeed, we know that the cercaria of *Trichobilharzia* are capable of causing a dermatitis known as 'swimmer's itch'. Recently, B. de Meillon and N. Stoffberg[2] have reported the first case in Africa of 'swimmer's itch', and I described, at Astrida (Ruanda-Urundi), a new furcocercaria of the Ocellata group which produces experimentally the same skin affection[3].

Up to now, no attention has been paid to the role that cercaria could take in the pathogeny of pruriginous skin diseases in Central Africa. I am reporting my observations in order to direct attention to this highly important matter.

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Sulphate Deficiency of Lake Victoria

An article by Beauchamp[1] suggests that a sulphur shortage in Lake Victoria is a factor limiting the growth-rate of fish. Owing to the fact that sulphates are removed from the water by biological precipitation in the form of plant and animal remains, Beauchamp suggests that the sulphate ultimately becomes anaerobically reduced to insoluble and unavailable sulphides which accumulate in the mud of the lake bed. Thus, although the water is deficient in sulphur, the element may well be present in large quantities at the bottom of the lake. In order to obtain facts as to the distribution of sulphur in the water, mud and vegetation of Lake Victoria, a preliminary investigation has been undertaken in the small, northern area around Jinja.

So far as the area examined is concerned, the results have confirmed Beauchamp's statement that the water of the lake is deficient in sulphur. The sulphate concentration was less than one part per million at all depths, and the total sulphur content was mainly one to two parts per million. The analyses of the muds have revealed several interesting facts. Sulphur was present in abundance (3,000–20,000 p.p.m. dry mud), not as expected in the reduced form of sulphide but practically wholly in the organic form. Only

about 1–4 per cent of the total sulphur was present as sulphide and 2–8 per cent as sulphate. Iron was present in both the reduced and oxidized forms in approximately equal proportions, and the oxidation-reduction potentials indicated a condition more on the oxidizing side than the reducing. These results seem to indicate that anaerobic conditions do not exist to any great degree at the lake bottom. Koyama *et al.*[2] found a similar lack of reduced sulphur in certain lakes in Japan, and they attributed this to low iron contents associated with high manganese contents. The mud of Lake Victoria, although containing appreciable amounts of manganese, is relatively rich in iron and thus the same explanation may not apply.

The next point arising from the analyses is that although the mud-surface contained considerable amounts of sulphate, the water immediately above it was devoid of the ion. For example, one mud-surface contained 700 p.p.m. sulphate–sulphur by Morgan's reagent, yet the water filtered from it had less than 1 p.p.m. A similar condition has been found by Koyama *et al.* in Japan. These workers suggested that a colloidal ferric complex selectively sorbs sulphate ions from the water. Mortimer[3] found colloidal ferric complexes in English lake muds that adsorbed sulphates and other ions. On reduction, these complexes were destroyed and liberated the adsorbed ions; this was controlled by the balance between the reducing power of the mud and the amount of oxygen supplied to its surface. As the results for Lake Victoria have shown the muds to be in an oxidized rather than a reduced state, it can be expected that similar adsorbing processes would occur. This conclusion suggests that the observed shortage of soluble sulphates in the water is due, not to their reduction to sulphides, but to the oxidized state of the mud-surfaces.

Sulphates are removed from the water biologically in the formation of plankton and other vegetable matter, and thus sulphur is also incorporated into the mud in the organic form. Beauchamp has stated that the limiting factor in lake fertility is the rate of decomposition of such precipitated organic matter. However, as the reduction of the mud-surface could increase the supply of soluble nutrients, the oxidation-reduction potential of the mud is also an important factor affecting fertility.

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Crystal Structure of Tobermorite

We have examined the crystal structure of tobermorite, using crystals given to us by Mr. J. D. C. McConnell, who has published a preliminary description of them[1]. The substance is a hydrated calcium silicate, closely related to, or identical with, the calcium silicate hydrate I found by Taylor[2] in set cements. Its composition, as found by McConnell[1], is $Ca_5Si_6O_{22}H_{10}$, and this is compatible with our present results, so far as they go.

The crystals, a few tenths of a millimetre long, were studied by Weissenberg and oscillation photographs. They turned out to be composite, giving doubled spots, and also giving diffuse scattering of a kind which indicates structural 'mistakes', rather similar to, but not identical with, those found in β-wollastonite[3]. In spite of these effects (which are being studied, but will not be described in detail here) it proved possible to determine the structure in general outline.

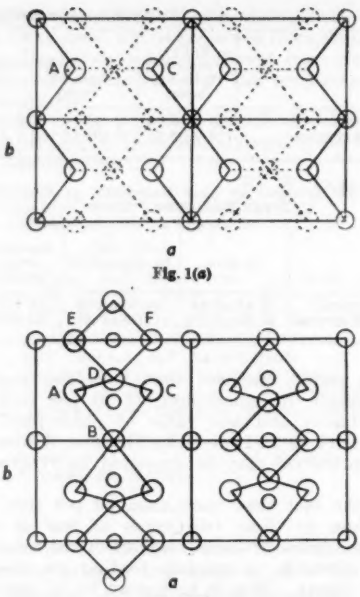

Fig. 1(*a*)

Fig. 1(*b*)

Fig. 1. Small circles Si, intermediate circles Ca, large circles O. Atoms and bonds shown dotted lie below middle of layer. (*a*) Tobermorite: two central sheets of layer projected on (001)—idealized. (*b*) Tobermorite: upper half of layer projected on (001)—idealized

The crystal structure is very nearly orthorhombic. It can be described on orthogonal axes with $a = 11{\cdot}3$ A., $b = 7{\cdot}33$ A., $c = 22{\cdot}6$ A.; cell-contents, four formula-units. There are systematic absences of hkl for $h + k$ odd and $\frac{1}{2}(h + k) + l$ odd, indicating that the true unit cell is smaller and implying a symmetry which cannot be greater than monoclinic, with c as the possible symmetry direction. There are systematic weaknesses of hkl for h odd or k odd, indicating a close similarity between the four quarters of the pseudo-orthorhombic cell. (It is convenient to continue to use this cell, and the axes defined by it.)

The cell contains two identical complex layers parallel to (001), displaced relative to one another in projection on (001), and each having a centre of symmetry (at least to the present degree of approximation). Each layer has two central sheets, of composition $4CaO_3$, arranged so that each calcium has four oxygen neighbours in its own sheet and two in the sheet at the next level (see Fig. 1*a*). Each pair of adjacent oxygens, such as AC, forms one edge of a tetrahedron containing silicon. These tetrahedra are joined into chains running parallel to b, as shown in Fig. 1*b*. Both Figs. 1*a* and 1*b* are slightly idealized; the actual chains are somewhat puckered.

This arrangement, a complex layer with the composition $4(Ca_2Si_3O_8)$, forms the backbone of the tobermorite structure. It is rather like a piece of

double-sided corrugated paper, having a strong central sheet reinforced on each surface by longitudinal ridges; but the ridges are themselves toothed, since *E*, *F* (Fig. 1*b*) are at a considerably higher level than *B*. Two sheets pack together with their ridges superimposed vertically. There are grooves between the ridges, and these or the interlayer spaces must hold the remaining calcium and oxygen atoms, but their detailed positions are not yet known. Neither is it known whether the hydrogen atoms are present wholly in OH groups or partly in H_2O; it is, however, certain that (if the composition stated above is correct) some hydrogens are attached to oxygens taking part in the Si—O chains.

Though the atomic positions are only known approximately as yet, they give reasonable interatomic distances and satisfactory agreement between observed and calculated *F*'s. The proposed structure accounts for both the platy and the fibrous character of the crystals. It also explains the observations of Kalousek[4] on the synthesis of the material from lime and silica; he found that the initial products up to about 100° C. were fibrous, and changed only slowly and at slightly higher temperatures into the platy tobermorite. Further, it allows a very natural explanation of the shrinkage of the (002) spacing which has been observed on dehydration[1], since removal of OH or H_2O from the grooves would permit two adjacent layers to pack together with their ridges interleaved instead of superimposed, while still leaving sufficient room to accommodate a calcium atom between them.

Further work is in progress, and it is hoped to obtain more accurate values of the atomic coordinates. We are very grateful to the Cement and Concrete Association for a grant to one of us (C. H. K.) which has made this work possible.

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The Gas-Multiplier: a New Type of Electron Multiplier

I have recently investigated the possibility of using the Townsend electron avalanche process in a gas in a stage-by-stage system to give a highly stable electron-multiplication factor, and have constructed for this purpose a new form of electron-multiplier referred to as a gas-multiplier[1]. This device is designed to permit electron-multiplication by the Townsend α-process, while restricting the accompanying processes which cause positive feedback by releasing further electrons in the input region. As is well known, the latter processes, particularly photoelectric effects and positive ion bombardment of the cathode, have set an upper limit of about 10^4 to the gas-amplification which has been practicable in single-stage devices such as proportional counters and gas-filled photoelectric cells, owing to the imminence of breakdown. The gas-multiplier is designed to be free from this limitation, by operating under conditions that are stable for any number of stages.

The chamber containing the gas is divided into stages by the electrodes, which are plane, parallel and equally spaced. The application of a specified voltage per stage therefore gives a uniform field throughout the working volume of the multiplier. The only communication between one stage and the next is through holes in a central circular area in the intervening electrode. These holes are small, closely spaced, and uniformly distributed, and occupy a fraction *B* of the total working area. The thickness of the electrodes is made small compared with the diameter of the holes, to avoid distortion of the field, and as an approximation each electrode may be taken to intercept all but a fraction *B* of all particles or photons approaching it from either side. This assumes that the gas pressure is sufficiently low and the hole-pattern sufficiently fine for the scattering action of the gas molecules to spread the electrons or ions from a particular hole laterally over several hole-spacings in crossing a stage. It also assumes that the coefficient of light reflexion at the surfaces is low, and that there is no systematic alignment of the holes in successive electrodes, which is ensured by using a suitable random method of arrangement.

There are two essential conditions for a satisfactory margin of stability in the operation of the multiplier. The first is that each stage should have a suitable margin of stability by itself, that is, with no voltage on the others, and this requires $\gamma \exp \alpha S \ll 1$, where α and γ are the usual Townsend coefficients, and *S* is the spacing between electrodes. The second condition is that in operation the flux of positive ions and of photons reaching a stage from a later stage should decrease markedly as the number of stages intervening increases, so that the total feedback does not greatly exceed that in the stage itself. Assuming that there is no appreciable ionization in the gas by positive ions at the field-strength and gas-pressure in use, the ratio of total flux to internal flux can be shown not to exceed $\frac{1}{1-GB}$, for any number of stages, where *G* is the gain per stage. It is therefore desirable that *GB* should not be greater than $\frac{1}{2}$, say. Provided that both the above conditions are satisfied, the feedback present has only a small effect on the gain, and, neglecting edge effects, *G* is approximately equal to $B \exp \alpha S$.

Table 1 shows a set of operating conditions used and the results observed. These results refer only to a preliminary experiment which was made to demonstrate the action of the multiplier, and was not designed to provide accurate measurements under closely controlled conditions. The rise- and decay-time is considered to be mainly due to the collection of the positive ions in the last stage. No appreciable delay or distortion other than this was observed as the number of stages was increased, provided that the output current did not exceed the value stated, which is of the order at which space-

Table 1

Diameter of perforated areas	3·81 cm.
Electrode spacing (*S*)	1·92 cm.
Hole diameter	0·079 cm.
Hole spacing (square pattern)	0·198 cm.
Electrode thickness (brass)	0·013 cm.
Area ratio (*B*)	0·125
Gas pressure (room air)	0·25 mm. mercury
Breakdown voltage, single stage	500 V.
Breakdown voltage per stage (8 stages, no input)	250 V.
Operating voltage per stage	160 V.
Input pulse length	40 μsec.
Pulse repetition frequency	50 sec.$^{-1}$
Gain per stage (*G*)	3·2
Rise and decay time	< 10 μsec.
Maximum undistorted peak output	c. 20 μamp.

charge effects are to be expected with an input pulse longer than the collection time. Larger currents show a greater gain than normal, and may initiate breakdown if excessive.

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[1] Provisional patent filed.

A Film Radiometer for Centimetre Wave-lengths

Thermal methods for the measurement of power at centimetre wave-lengths normally involve a substitution process in which the high-frequency power is assumed to be identical in magnitude with the d.c. power causing the same rise in temperature or change in resistance. While in some techniques this assumption results in no appreciable error, it is a general limitation of thermal methods that the high-frequency and d.c. powers are not dissipated in precisely the same manner. This feature of existing methods is particularly evident at low power-levels, of the order of 1 milliwatt, at wave-lengths of 3 cm. and less. Although a calibration of centimetre-wave milliwattmeters can be made against standard equipment operating at higher power-levels, this operation requires much auxiliary apparatus and attenuation measurements of high precision. There is a need, therefore, for further convenient power-measuring techniques at the milliwatt-level in which the limitations inherent in existing methods are avoided. It seems probable that a form of film radiometer or bolometer, in which the ideal of accurate substitution of d.c. power for high-frequency power is approached very closely, will fulfil these requirements; the results of some preliminary experiments in the development of such an instrument are summarized in this communication.

Very few direct measurements of power at centimetre wave-lengths using resistive films appear to have been made, and the only published information of which I am aware relates to extended films placed along the axis of a waveguide[1,2]. It has been known for some time, however, that a thin transverse film having a surface resistivity equal to the wave impedance of the waveguide forms a reflexion-less termination when followed at a distance of $\lambda_g/4$ by a perfect reflector (λ_g being the wave-length in the guide), and a modification of this arrangement is described below.

The problem of ensuring equivalent heating effects of high-frequency and d.c. power is obviously still considerable in a resistive film extending across the waveguide; fortunately, it is still possible to terminate a rectangular waveguide in its characteristic impedance by the use of a relatively narrow strip extending across the waveguide from the centre of the broad face. Such a strip is located in a region of very nearly uniform transverse electric and magnetic fields for the dominant or H_{01} mode, and the difficulty of attaching suitable d.c. connexions is at the same time much reduced. In the present experiments, a strip 0·35 cm. wide of surface resistivity 180 ohms per square has been used in a standard 3-cm. band waveguide, so giving a d.c. resistance of approximately 500 ohms between top and bottom edges of the strip. Impedance measurements confirm that the strip behaves, to a close approximation, as a pure shunt resistance. In addition, with the reflecting plunger fixed at a distance of $\lambda_g/4$ at a mid-band wave-length of 3·2 cm., an input-voltage standing-wave ratio of 0·9 or better can be achieved over a 10 per cent band-width by preliminary adjustments of width of film. The strip is insulated from the waveguide at one end and can be connected in a d.c. circuit for calibration purposes.

Theoretically, either changes of resistance or a rise in temperature can be observed; so far, only the latter quantity has been determined by the simple method of attaching a single copper – eureka thermocouple to the centre of the strip with the wires of the couple fixed at right angles to the electric field of the H_{01} mode. A similar thermocouple is placed on the external wall of the waveguide close to the strip, and a steady-state deflexion of about 10 cm. per mW. is obtained on a galvanometer scale after a period of one to two minutes.

Preliminary comparisons, at power-levels of 2–3 mW., with other calibrated equipment have shown that the errors in a d.c. calibration of the instrument are probably not more than a few per cent. Further experiments, using metallic films deposited on mica, are in progress in order to investigate the full possibilities of this form of film radiometer, and a complete account of the work will be published in due course.

I am indebted to Dr. J. A. Saxton for advice in the preparation of this communication. The work described was carried out as part of the programme of the Radio Research Board, and is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

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Slough. Oct. 26.

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Metal-catalysed Hydrolysis of Thiophosphoric Esters

Studies on the hydrolysis of parathion (O-O-diethyl-O-*p*-nitrophenylphosphorothionate) and E.P.N. (thiono-benzene phosphoric acid O-ethyl-O-*p*-nitrophenylester) at *p*H 7 showed unexpectedly that traces of some metal ions, for example, cupric ions, have a marked catalytic effect.

At *p*H 7·8–8·6, at which the measurements were made, the catalysis of the hydrolysis by hydroxyl ions is negligible, so that we have primarily reaction with water. The reaction was followed at 40° C. by measuring as a function of time the optical density of the liberated nitrophenolate in a Beckman spectrophotometer *D.U.*

Assuming a reaction of the first order, we obtain from the general formula for the velocity constant $(k=(1/t)\ln a/(a-x))$, $k=(1/t)\ln(D_\infty - D_0)/(D_\infty - D_t)$, where D_0, D_t and D_∞ are the optical densities at times 0, t and infinity[1].

The buffer solution used was borax–hydrochloric acid (conc. borax $\pm$ 0·03 mol./l.). Addition of 20 per cent ethanol in the case of parathion and of 40 per cent for E.P.N. was necessary because of the limited solubility of these compounds in water. Great care was taken to avoid impurities, as it proved that metals even catalysed in concentrations of 10^{-8} mol./l.

The reagents used were analytical grade; we are indebted to the American Cyanamid Co. and the Dupont de Nemours Corporation for providing

Table 1. Hydrolysis of Parathion, Paraoxon and E.P.N. in a Glass Vessel at 40° C.

Ester	Metal	Concentration metal (mol./l.)	Concentration ester (mol./l.)	*p*H	First-order constant, k (hr.$^{-1}$)	$\frac{k \text{ (metal)}}{k \text{ (control)}}$
Parathion	Copper	$0{\cdot}32 \times 10^{-6}$	$0{\cdot}11 \times 10^{-3}$	8·50	$1{\cdot}50 \times 10^{-3}$	20·0
	Control	complexon	,,	8·55	$0{\cdot}75 \times 10^{-4}$	1·0
E.P.N.	Copper	$0{\cdot}32 \times 10^{-6}$	$0{\cdot}105 \times 10^{-3}$	8·25	$1{\cdot}48 \times 10^{-3}$	47·6
	Control	complexon	,,	8·03	$0{\cdot}31 \times 10^{-4}$	1·0
Paraoxon	Copper	$0{\cdot}32 \times 10^{-6}$	$0{\cdot}113 \times 10^{-3}$	7·87	$0{\cdot}40 \times 10^{-3}$	1·7
	Control	complexon	,,	7·80	$0{\cdot}23 \times 10^{-3}$	1·0

Hydrolysis of Parathion with Addition of Calcium Ions in a Glass Vessel at 40° C.

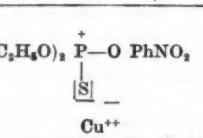
Concentration of calcium (mol./l.)	Concentration of parathion (mol./l.)	*p*H	First-order constant k (hr.$^{-1}$)	$\frac{k \text{ (metal)}}{k \text{ (control)}}$
1×10^{-4}	$0{\cdot}11 \times 10^{-3}$	8·66	$0{\cdot}507 \times 10^{-3}$	6·8
1×10^{-4}	,,	8·79	$0{\cdot}871 \times 10^{-3}$	11·6
1×10^{-4}	,,	8·68	$0{\cdot}677 \times 10^{-3}$	9·0
1×10^{-2}	,,	8·65	$0{\cdot}709 \times 10^{-3}$	9·5
1×10^{-2}	,,	8·66	$0{\cdot}691 \times 10^{-3}$	9·2
Control solution (complexon)	$0{\cdot}113 \times 10^{-3}$	8·55	$0{\cdot}75 \times 10^{-4}$	1·0

purified samples of parathion and E.P.N. Water, ethanol and hydrochloric acid were redistilled in an all-glass apparatus. All glassware was meticulously cleaned with a complexon solution (disodium-ethylenediamine tetraacetic acid) and with redistilled water.

The volumetric flasks in which the reaction took place were allowed to stand with buffer solution for several days. During the reaction the solutions were kept in the dark.

With these precautions, it was possible to obtain consistent results in each run. However, the use of a newly prepared buffer solution led to slightly different rate-constants (mean deviation ± 10 per cent) without altering the general picture of the catalysis. As reference we used a solution containing 10^{-2} mol./l. of complexon III, to bring down the concentration of most metal ions present as impurities to less than 10^{-15} mol./l. With the concentrations of cupric ions used, no hydroxide formation could be detected, in agreement with the solubility data given by Seidell[2]. The results are shown in Table 1.

When the effect was first found, it was thought that it might be due to the catalytic oxidation of parathion to paraoxon—the oxygen analogue of parathion[3]. This, however, was not the case, as the hydrolysis constant of paraoxon (see Table 1) is lower than the copper-catalysed hydrolysis of parathion. (The effect of cupric ions on the hydrolysis of paraoxon is very small.) Moreover, an experiment in which oxygen was meticulously excluded by keeping the solution under high vacuum ($\sim 10^{-4}$ mm. mercury) showed that the catalysis continued. The effect of other ions (magnesium, calcium, barium, aluminium, cobalt, cadmium and silver) was also investigated. In a glass vessel there was a marked enhancement of the hydrolysis. As we found very little variation of the reaction velocity with the metal ion concentration, the reaction was also measured in a polyethylene flask. Only in the case of copper ions was catalytic action found. The other metals investigated showed about the same velocity as the reference solution (with added complexon) in glass. The cause of this behaviour is being investigated, especially whether there is a real heterogeneous catalysis or if copper ions are liberated from the glass by absorption of other ions. In alkaline hydrolysis of parathion, cupric ions had no catalytic effect. To explain this phenomenon complex formation in much the same way as recently assumed by Wagner-Jauregg[4] for the hydrolysis of di*iso*propylphosphorofluoridate may be considered.



Such a complex will have a more polar P—S bond and as a consequence will show more 'opposing resonance' and a reduced stability.

It is well known that thiophosphoric esters form complexes with salts of heavy metals[5]. An unexplained fact so far is the obvious specificity of cupric ions. It may well be that this type of catalysis, which occurs at very low concentrations, plays an important part in the degradation of spray residues.

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Paper Chromatographic Identification of the 2 : 4-Dinitrophenyl-Derivatives of Aliphatic Amines

During recent work on the structure of bacitracin *A*, the identity of small amounts of aliphatic amines was confirmed by allowing them to react with 1 : 2 : 4-fluorodinitrobenzene[1] and chromatographing the resulting dinitrophenyl derivatives on paper[2]. A number of primary aliphatic amines can readily be separated by chromatography on paper[3], or by ionophoresis on paper at *p*H 7 using collidine acetate buffer[3,4], and the spots revealed with ninhydrin. Schwyzer has separated certain primary, secondary and tertiary amines by paper chromatography, the spots being revealed by spraying with an indicator[5]. However, in view of the fact that the technique described here will give further evidence of the nature of a mixture of primary and secondary amines and ammonia, and that 0·5 μgm. or less of the dinitrophenyl-amines can be detected on the chromatograms under ultra-violet light, it seemed worth while to place it on record.

A small sample of the amine is allowed to react with 1 : 2 : 4-fluorodinitrobenzene and the dinitrophenyl-derivative is identified by reversed-phase chromatography on paper. In a typical experiment, fluorodinitrobenzene (0·15 μl.) in 0·2 ml. of ethanol was added to 10 μgm. of the amine or its hydrochloride in 0·1 ml. water, followed by 0·2 *N* sodium bicarbonate solution (0·1 ml.). After standing for 15 min. at room temperature, the solution was placed at 105° in a sealed tube for 2 hr. Excess fluorodinitrobenzene was removed by addition of a solution of glycine (0·1 ml. containing 300 μgm.) and allowing the mixture to stand for 2 hr. at room temperature[6]. Ethanol was then removed in a vacuum desiccator, 0·15 ml. of 0·2 *N* sodium bicarbonate solution added and the dinitrophenyl-amines extracted into ether. The residue obtained on evaporation of the ether solution was dissolved in 5 μl. ethanol and 1·7 μl. of the solution applied to a paper chromatogram. Whatman No. 1 paper treated with Dow Corning silicone No. 1107[7] was used and the chromatograms were developed with the more polar phase obtained on mixing methanol, chloroform and water (10 : 10 : 6 by volume). The chromatograms were run as recommended by Kritchevsky and Tiselius[7] and allowed to develop for 16 hr., when the solvent front had run off the bottom of the sheet (35 cm. long). 2 : 4-Dinitroaniline (R_F, 0·60) had then travelled 26·25 cm. The values of R_A (defined as the ratio of the distance moved by the substance to the distance moved by 2 : 4-dinitroaniline) and of R_F for the dinitrophenyl-derivatives of the amines used are shown in Table 1.

Table 1. Behaviour of Dinitrophenyl-Amines on Paper Chromatograms

$$R_A = \frac{\text{Distance moved by substance}}{\text{Distance moved by 2 : 4-dinitroaniline}}$$

Dinitrophenyl-derivative of	R_A	R_F
Ammonia	1·00	0·60
Methylamine	0·88	0·53
Dimethylamine	0·80	0·48
Ethylamine	0·67	0·40
*iso*Propylamine	0·47	0·28
Diethylamine	0·44	0·26
*iso*Butylamine	0·33	0·20
*iso*Amylamine	0·20	0·12
*iso*Hexylamine	0·12	0·07

By plotting the values of $R_M \left[= \log_{10} \left(\frac{1}{R_F} - 1 \right) \right]$ for the dinitrophenyl-derivatives of the primary and secondary amines against the number of methylene groups in the amines, two parallel straight lines are obtained for the two homologous series (cf. Bate-Smith and Westall[8]).

With the small spots applied to the chromatograms, all the dinitrophenyl-amines listed are separated from each other except the derivatives of *iso*propylamine and diethylamine. These two substances can be separated by prolonged development of the chromatogram. The spots can easily be eluted from the appropriate areas of the chromatograms with 3 ml. of ethanol. Measurement of the optical density of the resulting solutions at 345 mμ shows that the primary and secondary amines used have reacted almost quantitatively with 1 : 2 : 4-fluorodinitrobenzene. Ammonia gives only about 50 per cent of the expected yield and the high temperature used for the reaction is required to obtain this yield. The low solubility of the dinitrophenyl-derivative of methylamine in ethanol may also result in low recoveries in certain cases. Where an elongated spot due to dinitrophenyl-methylamine will not interfere with other substances, the spots may be applied to the chromatogram in ethanol–acetone (1 : 1) instead of ethanol. The theoretical recovery of dinitrophenyl-methylamine is then obtained. The method therefore appears to have potentialities as a semi-quantitative tool.

Since the dinitrophenyl derivatives of the primary aliphatic amines show an absorption maximum at 345 mμ, while the corresponding derivatives of secondary amines show a maximum at 365–370 mμ, the measurement of the optical density of an eluate at two wave-lengths provides corroborative evidence as to whether the substance is derived from a primary or secondary amine.

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Oct. 26.

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[8] Bate-Smith, E. C., and Westall, R. G., *Biochim. Biophys. Acta*, **4**, 427 (1950).

Erosion in Meanders

In connexion with the communication by J. H. Horlock in *Nature* of November 26, p. 1034, I am writing to urge that the term 'meander' should be strictly limited to natural meanders, not to bends due to secondary flows. The term 'meander' is derived from the River Meander, which swings from bank to bank in an almost perfect pattern. The Central Board of Irrigation, India[1], many years ago defined "a meandering river as a river which follows a sinuous path due to natural physical causes, not imposed by external restraint". The experiments quoted were carried out under very unnatural conditions and hence produced highly unnatural results.

C. C. Inglis
(Director)

Hydraulics Research Station,
Howbery Park,
Wallingford, Berks.

[1] See "The Behaviour and Control of Rivers and Canals (with the aid of Models)"; obtainable from Publications Branch, General Department, India House, Aldwych, W.C.2. 13*s*.

I am grateful to Sir Claude Inglis for pointing out that the term 'meander' should be restricted to bends similar to natural meanders. I agree that the initial shapes of the bends used in the experiments described in my communication were not true meanders; but the point of the experiment was to demonstrate that the nature of the erosion in such bends would depend largely on the initial curvature at entry to the bend. Such artificial bends probably develop into natural meanders. Subsequent experiments on natural meanders of similar amplitude and wave-length show that erosion occurs on the banks on the outside of the bends, and not on one bank, as in the original experiments with artificial bends.

J. H. Horlock

Engineering Laboratory,
Cambridge.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 27

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE (at Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. Morris Ginsberg: "Reason and Experience in Ethics".*

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Prof. Glenn Sonnedecker (U.S.A.): "Structure and Stresses of American Pharmacy".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the WOOLWICH POLYTECHNIC SCIENTIFIC SOCIETY, at the Woolwich Polytechnic, London, S.W.18), at 7.30 p.m.—Dr. J. W. Rodgers: "The Extraction and Uses of Titanium and Zirconium".

Tuesday, February 28

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. H. Judith Grenville-Wells: "Crystals, Temporary and Permanent: (2) Diamond".*

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT and SUPPLY SECTIONS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. M. W. Makowski and Mr. K. Mochlinski: "An Evaluation of Two Rapid Methods of Assessing the Thermal Resistivity of Soil".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. J. M. Zarek: "General Biomechanics".*

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. Anthony J. Barrett: "Use of Elementary Plasticity in Design".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. B. J. Terrell: "Measurement of Angular Speed".

Wednesday, February 29

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting. 5 p.m.—Sir William Slater: "The Evolution of Agricultural Research" (Bernard Dyer Memorial Lecture).

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Discussion on "Technique of Microwave Measurements", opened by Mr. E. M. Wareham.

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. N. Uri: "Some New Aspects of the Mechanism of Fat Oxidation and Its Inhibition".

Thursday, March 1

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. A. J. Arkell: "Boats and Pyramids in Ancient Egypt".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Geoffrey Taylor, F.R.S.: "Fluid Flow in Regions Bounded by Porous Surfaces"; Mr. C. N. Davies and Mr. C. V. Peetz: "Impingement of Particles on a Transverse Cylinder".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. S. Brian Kendall: "Host-parasite Relationships between Liver-flukes and *Lymnaeidae*"; Dr. L. P. Joyner and Dr. S. Brian Kendall: "Potentiation of the Coccidiostatic Activity of Sulphonamides by Pyrimethamine".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Recruitment in the Engineering Profession".

UNIVERSITY COLLEGE, LONDON (in the Chemistry Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. R. S. Nyholm: "The Renaissance of Inorganic Chemistry" (Inaugural Lecture).*

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. T. C. Powers (U.S.A.): "Physical Structure and Engineering Properties of Concrete".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. E. S. Moult: "Power Plants for Supersonic Flight".

Friday, March 2

ASSOCIATION OF APPLIED BIOLOGISTS (in the Meeting Room of the Royal Entomological Society of London, 41 Queen's Gate, South Kensington, London, S.W.7), at 10.45 a.m.—Meeting on "Clover Seed Production".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Arthur Bryant: "Samuel Pepys".

Saturday, March 3

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. D. Chilton: "The Weather Glass".*

BRITISH INTERPLANETARY SOCIETY (in the York Hall of Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Prof. A. D. Baxter: "Combustion Chambers for Rocket Engines".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ELECTRICAL ENGINEERING—The Secretary of University Court, The University, Glasgow (February 29).

SENIOR LECTURER IN CHEMISTRY at Birkenhead Technical College—The Director of Education, 63 Hamilton Square, Birkenhead (February 29).

SENIOR RESEARCH FELLOW (with an honours B.Sc. degree in chemistry or biochemistry and research experience) to work in the Department of Biological Chemistry on the chemical aspects of a research programme concerned with the fluorescent labelling of proteins, carried out jointly by the Departments of Pathology, Bacteriology and Biological Chemistry—The Secretary, The University, Aberdeen (February 29).

COMPUTER (preferably graduate) for skilled work in mathematical statistics and some applied mathematics—The Registrar, King's College, Newcastle-upon-Tyne (March 3).

ASSISTANT (with special interests in vertebrate palæontology) IN THE DEPARTMENT OF GEOLOGY in St. Salvator's College, St. Andrews—Joint Clerk to the University Court, The University, College Gate, St. Andrews (March 9).

SCIENTIFIC OFFICER and EXPERIMENTAL or ASSISTANT EXPERIMENTAL OFFICER in the Brown Trout Research Laboratory, Pitlochry, for duties chiefly concerned with salmon research—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (March 10).

ASSISTANT EXPERIMENTAL OFFICER (with a pass B.Sc. degree or equivalent) IN THE DEPARTMENT OF POTATO GENETICS, for general maintenance of stocks and tests for resistance of tuberous Solanums—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (March 12).

DEMONSTRATOR IN GEOGRAPHY—The Registrar, University College of North Staffordshire, Keele, Staffs (March 12).

MICROBIOLOGIST (Scientific Officer or Senior Scientific Officer grade), to undertake investigations of the microflora, mainly that of the fungal microflora of the roots of grassland species during their growth and decay—The Secretary, Grassland Research Institute, Hurley, Maidenhead (March 12).

LECTURER (with a special qualification in algebra and/or geometry) IN THE DEPARTMENT OF MATHEMATICS—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (March 13).

RESEARCH FELLOW IN COSMIC RAYS for work which will be concerned largely with time variations of intensity and the origin of cosmic rays—The Registrar, University of Tasmania, Box 647C, G.P.O., Hobart, Tasmania (March 15).

ASSISTANT (preferably with a degree in one of the natural sciences) IN CHARGE OF THE NATURAL SCIENCES LIBRARY—The Registrar, University College, Singleton Park, Swansea (March 17).

INTERNATIONAL WOOL SECRETARIAT RESEARCH FELLOW (microbiologist or bacteriologist), for work on the interconversion of steroids and triterpenes—The Registrar, The University, Leeds 2 (March 17).

LECTURER IN CHEMICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (March 17).

LECTURER IN EXPERIMENTAL PHARMACOLOGY—Secretary of University Court, The University, Glasgow (March 17).

LECTURER (with a good honours degree in geography) IN GEOGRAPHY in St. Salvator's College—Joint Clerk to the University Court, The University, College Gate, St. Andrews (March 17).

SENIOR RESEARCH FELLOW (graduate in science or chemical engineering, with experience in coal research) IN COAL RESEARCH at the University of Sydney, Australia, to plan and undertake research on occurrence, nature or utilization of coal—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 17).

SENIOR LECTURER (with a degree in metallurgy or equivalent, and industrial and research experience) IN METALLURGY—The Registrar, College of Technology, Manchester 1 (March 19).

METALLURGIST or METAL PHYSICIST (with a first- or second-class honours degree or equivalent), and an INORGANIC CHEMIST (with a first- or second-class honours degree or equivalent), IN THE METALLURGY DIVISION, National Physical Laboratory, Teddington, Middlesex, for work on new analytical techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.65/6A (March 28).

LECTURER (with experience either in theoretical or experimental physics) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (March 29).

ASSISTANT LECTURERS (2) (one in pure, the other in applied mathematics) IN MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (March 30).

HEAD (with good academic qualifications and teaching and/or industrial experience) OF THE DEPARTMENT OF APPLIED CHEMISTRY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (March 30).

G. F. GRANT CHAIR OF CHEMISTRY—The Registrar, The University, Hull (March 31).

LECTURER IN MECHANICAL ENGINEERING—Joint Clerk to the University Court, Queen's College, Dundee (March 31).

LECTURER (with special qualifications in physical chemistry) IN CHEMISTRY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 31).

TECHNICIAN IN THE DEPARTMENT OF ZOOLOGY—The Secretary, The University, Exeter (March 31).

LECTURER or ASSISTANT LECTURER IN STATISTICS—The Registrar, The University, Leeds 2 (April 2).

TURNER AND NEWALL RESEARCH FELLOWS IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS AND ALLIED SUBJECTS—The Registrar The University, Manchester (April 30).

BACTERIOLOGIST (graduate with some general bacteriological experience), for work on phage-typing of staphylococci, with a view

to taking responsibility, under the Director, for the routine typing service—The Director, Central Public Health Laboratory, Colindale, London, N.W.9.

Biochemist (with a first- or second-class honours degree in biochemistry or equivalent qualification, and postgraduate research experience), to assist in the study of certain physico-chemical properties of mucin—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 56/3.

Brush Research Fellow (honours graduate in science or engineering), for research in the mechanical and electrical aspects of power generation control and utilization—The Registrar, The University, Nottingham.

Demonstrator (with a wide practical knowledge of microbiological techniques and preferably with experience in the food or fermentation industries), for work associated with teaching of practical microbiology—The Secretary, The Royal Technical College, Glasgow, C.1.

Electroencephalograph Recordist (Grade 1)—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

Lecturer (Grade I) in the Department of Zoology at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Lecturer in Physics, with special reference to the physics of nuclear reactors—The Registrar, The University, Birmingham 15.

Lecturer (with an honours degree in physics together with suitable teaching experience) in Physics—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3.

Lecturers (2) (with research interests in applied mathematics, preferably in fluid dynamics) in Mathematics—The Secretary, The Royal Technical College, Glasgow.

Master to teach Mathematics up to advanced level standard—The Director of Studies, Nautical College, Pangbourne, Berkshire.

Master (under 35, with Oxford or Cambridge degree) to teach Biology (mainly botany) with subsidiary chemistry—The Headmaster, The College, Winchester.

Principal Lecturer (with high academic qualifications and preferably some industrial experience) in Food Science—The Secretary-Treasurer, Royal Technical College, George Street, Glasgow, C.1.

Scientific Officer (with an honours degree in biochemistry or physiology, and preferably with previous experience in biological research) in the Nutrition Department, to take part in work that will include the determination of the biological value of proteins, the study of calcium and phosphorus metabolism including the use of radioactive tracers, vitamin A and D assays and general nutritional experiments with rats—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading, quoting 56/5.

Scientific Secretary (with a first- or second-class honours degree in agriculture or other natural science with at least three years appropriate postgraduate experience and some administrative experience) to the Director of the West African Cocoa Research Institute, Gold Coast, to assist the Director in the work of the Institute including technical correspondence, preparation of reports and publications, minutes and other technical matters—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.197/200/012.

Senior Lecturer in Physiology and Pharmacology, at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

Senior Lecturer (with a good honours degree and design experience in nuclear power plant) in Nuclear Power Engineering—The Secretary, The Royal Technical College, Glasgow.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Planning. Vol. 21, No. 390 (12 December 1955): New Writing on Wages—1. Pp. 245–260. 2*s.* 6*d.* Vol. 21, No. 391 (12 December 1955): New Writing on Wages—2. Pp. 261–276. 2*s.* 6*d.* (London: Political and Economic Planning, 1955.) [1312

Institution of Professional Civil Servants. Special Report of the National Executive Committee of the Institution of Professional Civil Servants on the Report of the Royal Commission on the Civil Service, 1953–55. Pp. 34. (London: Institution of Professional Civil Servants, 1955.) [1312

British Gelatine and Glue Research Association. Seventh Annual Report for the year October 1954 to September 1955. Pp. 16. (London: British Gelatine and Glue Research Association, 1955.) [1312

Year Book of the Physical Society, 1955. Pp. iii+92+4 plates. (London: Physical Society, 1955.) Price to non-members, 10*s.* [1312

University College, London: a Survey 1950–1955. Pp. 70+9 plates. (London: University College, London, 1955.) [1312

Report on the Work of the British Council, 1934–1955. (Twenty-first Anniversary Report.) Pp. vi+121+6 plates. (London: British Council, 1955.) 2*s.* 6*d.* [1612

Scottish Home Department. Freshwater and Salmon Fisheries Research Series. No. 10: Movements of Salmon and Sea Trout, chiefly Kelts, and of Brown Trout Tagged in the Tweed between January and May, 1937 and 1938. By the late G. Herbert Nall. Pp. 19. (Edinburgh: H.M. Stationery Office, 1955.) 4*s.* net. [1612

Bulletin of the British Museum (Natural History). Entomology. Vol. 4, No. 1: A Study of African Chironomidae, Part 1. By Paul Freeman. Pp. 167+plate 1. 15*s.* Botany. Vol. 2, No. 2: Mosses of Dominica, British West Indies and Mosses of the Ecuadorian Andes Collected by P. R. Bell. By Edwin B. Bartram. Pp. 35–64. 6*s.* (London: British Museum (Natural History), 1955.) [1612

Maudsley, Mott and Mann on the Chemical Physiology and Pathology of the Mind. By Prof. H. McIlwain. (An inaugural lecture delivered at the Institute of Psychiatry, Maudsley Hospital, London, 14th April, 1955.) Pp. 26. (London: H. K. Lewis and Co., Ltd., 1955. Published for the Institute of Psychiatry.) 5*s.* net. [1612

Psychology and the Foundations of Psychiatry. By Prof. H. J. Eysenck. (An inaugural lecture delivered at the Institute of Psychiatry, Maudsley Hospital, London, 3rd February, 1955.) Pp. 32 (London: H. K. Lewis and Co., Ltd., 1955. Published for the Institute of Psychiatry.) 5*s.* net. [1612

Graphic Arts Focal Point. Vol. 1, No. 1. (An Ilford journal for all engaged in the Production of Printed Illustration.) Pp. 24. (London: Ilford Limited, 1955.) [21

Air Ministry: Meteorological Office. Meteorological Reports. No. 16: Winds Between 300 and 100 MB in the Tropics and Subtropics. By A. Gilchrist. Pp. ii+28. (M.O. 535 k.) (London: H.M. Stationery Office, 1955.) 2*s.* net. [21

Other Countries

Proceedings of the United States National Museum. Vol. 103, No. 3334: A Supplement to T. M. Tattersall's Review of the Mysidacea of the United States National Museum. By Albert H. Banner. Pp. 575–584. Vol. 103, No. 3336: Supplement and Corrections to J. A. Hyslop's Genotypes of the Elaterid Beetles of the World. By Ross H. Arnett, Jr. Pp. 599–620. Vol. 103, No. 3337: Neotropical Miridae. 64: New Bugs of the Subfamily Cylapinae (Hemiptera). By José C. M. Carvalho. Pp. 621–632. Vol. 104, No. 3338: Revision of the Vittate Species of the Chrysomelid Beetle Genus Disonycha from the Americas South of the United States. By Doris Holmes Blake. Pp. 1–86. Vol. 104, No. 3339: A Revision of the Nearctic Species of the Beetle Genus Meligethes (Nitidulidae). By Alan M. Easton. Pp. 87–104. Vol. 104, No. 3340: Four New Venezuelan Reduviid Bugs. By J. Maldonado Capriles. Pp. 105–114. Vol. 104, No. 3341: Some Polyclad Flatworms from the West Indies and Florida. By Libbie H. Hyman. Pp. 115–150. Vol. 104, No. 3342: Biology and Taxonomy of North American Beetles of the Subfamily Geotrupinae, with revision of the Genera Bolbocerosoma, Eucanthus, Geotrupes, and Peltotrupes (Scarabaeidae). By Henry F. Howden. Pp. 151–320+18 plates. Vol. 104, No. 3343: Fruit Flies of the Genus Tomoplagia Coquillett (Diptera, Tephritidae). By Martin L. Aczél. Pp. 321–412+plates 19–26. Vol. 104, No. 3344: Scarab Beetles of the Genus Psammodius in the Western Hemisphere. By O. L. Cartwright. Pp. 413–462. Vol. 104, No. 3348: Neotropical Miridae. 15: New Genera and Species of Bugs of the Tribe Termatophylini (Hemiptera: Deraeocorinae). By José C. M. Carvalho. Pp. 641–650+plate 31. Vol. 105, No. 3349: Notes on Shrimps from the Marshall Islands. By Fenner A. Chace, Jr. Pp. 1–22. Vol. 105, No. 3352: Some Polyclad Flatworms from Polynesia and Micronesia. By Libbie H. Hyman. Pp. 65–82. Vol. 105, No. 3353: Biting Lice of the Genus Saemundssonia (Mallophaga: Philopteridae) Occurring on Terns. By Ronald A. Ward. Pp. 83–100. Vol. 105, No. 3355: A Review of the New World Flies of the Genus Conops and Allies (Diptera: Conopidae). By Sidney Camras. Pp. 155–188. (Washington, D.C.: Smithsonian Institution, United States National Museum, 1954 and 1955.) [1312

Transvaal Museum, Pretoria, S. Africa. Report for the year ending 31st March, 1955. Pp. 42. (Pretoria: Transvaal Museum, 1955.) [1312

City of Launceston, Tasmania. Annual Report of the Queen Victoria Museum and Art Gallery, 1954–55. Pp. 8. (Launceston: Queen Victoria Museum and Art Gallery, 1955.) [1312

Nuclear Physics. Vol. 1, No. 1. Edited by Prof. L. Rosenfeld. Published Monthly. Subscription price of a volume of 700 pages: 53 florins; 106*s.*; 14 dollars. Postage 8*s.* (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1956.) [1312

National Research Council of Egypt. Bulletin of the Scientific and Technical Documentation Centre. Vol. 1, No. 2 (September 1955): Abstracts of Scientific and Technical Papers published in Egypt, and Papers received from Afghanistan, Cyprus, Iran, Iraq, Lebanon, Pakistan, Sudan and Syria. Pp. 10. Vol. 1, No. 3 (October, 1955): Abstracts of Scientific and Technical Papers published in Egypt and Papers received from Afghanistan, Cyprus, Iran, Iraq, Lebanon, Pakistan, Sudan and Syria. Pp. 14. (Cairo: National Research Council of Egypt, 1955.) [1312

Berichte des Deutschen Wetterdienstes. Nr. 19 (Band 3): Beitrag zur Messung der Lufttemperatur mit verschiedenen Formen Strahlungsschutzes. Von Wilhelm Bauer und Richard Buschner. Pp. 12. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) [1312

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Bureau Climatologique—Communication No. 10: Bulletin Climatologique Annuel du Congo Belge et du Ruanda-Urundi, Année 1954. Pp. 161. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) 120 francs. [1312

World Health Organization. Technical Report Series. No. 100: Amputees and Protheses—Report of a Conference on Prosthetics, Copenhagen, 23–28 August, 1954. Pp. 52. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 3*s.* 6*d.*; 0.60 dollars; 2 Swiss francs. [1612

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